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A STUDY OF THE INHERITANCE OF SPORE COLOUR AND PATHOGENICITY IN CROSSES BETWEEN PHYSIOLOGIC FORMS OF *PUCCINIA GRAMINIS TRITICI* *†

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INTRODUCTION

Two mutants of *Puccinia graminis tritici* Erikss. and Henn., one of which is orange in colour and the other greyish-brown were described by two of the authors (*4*) in a previous publication. The orange mutant appeared as a single pustule in a culture of form 9 which for six generations of uredinia had produced spores of normal colour; the so-called greyish-brown mutant appeared in the first uredinial generation of a culture derived from aeciospores and was identified as form 36.

Later work has shown that greyish-brown forms occur in cultures derived from aeciospores more commonly than was previously suspected. During the spring of 1927 and of 1928, one hundred and sixty-four separate cultures were made from aeciospores. Forty-two of the cultures were obtained from barberries in the field, and one hundred and twenty-two were obtained from barberries inoculated in the greenhouse. The source of the latter cultures was telia on *Hordeum jubatum,* collected in a small plot at the Agricultural College, Winnipeg. Three of the forty-two cultures derived from the naturally-infected barberries produced greyish-brown pustules. In the cultures derived from the artificially-inoculated barberries, the proportion was much greater. Forty-three of the one hundred and twenty-two cultures produced some greyish-brown pustules. From the greyish-brown pustules of each culture, inoculations of wheat seedlings were made, and the greyish-brown forms obtained in pure culture. Twenty-six of these proved to be form 36, the original greyish-brown form and seventeen of them were form 52, a form in which colour variation had not previously been observed.

As every greyish-brown culture originated from aeciospores, and none from field collections of urediniospores, a special effort was made during 1927 and 1928 to find greyish-brown uredinia in the field. Sixty-one uredinial collections were made from *Hordeum jubatum* and seven hundred and eighty from cereals. From only five of these were greyish-brown cultures obtained. Four of the five collections were from *Hordeum jubatum* which grew near an infected barberry bush, the fifth one was from wheat. As there were at this time in the greenhouse a number of the greyish-brown cultures, it is possible that contamination was respon-

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sible for the appearance of the greyish-brown rust in the fifth collection. Whether or not the four cultures originated in the first place on barberry and the fifth one by contamination, it is very clear that there is a marked contrast between the number of greyish-brown cultures derived from field collections of uredinia and those derived from the artificially-inoculated barberries mentioned above.

Why so many greyish-brown cultures arose from aecial material and so few from uredinial collections is not fully understood. It may be pointed out, however, that the greyish-brown urediniospores of form 36 show a much lower percentage of germination (53 per cent) than do the normally-coloured ones of the same form (86 per cent). During 1926, 1927 and 1928, form 36 was the most prevalent physiologic form in Western Canada, where 46 per cent of all the uredinial collections were made. If, as there is considerable evidence to show, the initial infections in this area arise from spores blown in from rust-infected areas farther south, the greyish-brown spores of form 36, being less viable, may perish before they are able to cause infections in Western Canada. The relatively low germinability of these spores may possibly account for the rarity of greyish-brown uredinia in the field. On the other hand, there is very little difference between the percentage of germination of the greyish-brown (85 per cent) and the normally coloured urediniospores of form 52. The reason advanced for the rarity of the greyish-brown uredinia of form 36, would therefore not be valid for the greyish-brown form 52, but form 52 is by no means a prevalent form in Canada. For instance, in 1927, when no less than two hundred and five uredinial collections of form 36 were made, the number of collections from which form 52 was isolated was only three. As this form is so rare, the chances of finding greyish-brown uredinia in so few collections would be very small indeed.

In view of the more recent work reported in this and another paper (*6*), it seems probable that the greyish-brown variant arose as a segregate from either form 36 or form 52, both of which appeared to be segregating for this colour.

The present paper presents the results from crosses between the orange-coloured form, here designated as form 9*a* (orange), and one or other of the greyish-brown forms, 36 (greyish-brown) or 52 (greyish-brown). Two other crosses are discussed, one between forms 9 and 15, both of normal colour, which gave rise to some whitish as well as to normally coloured aecia in a few pustules, the other between form 14 (normal colour) and form 36 (greyish-brown). The two main objectives of the study were:

(1) To investigate the inheritance of uredinial colour by means of a study of the first and second generation hybrids from crosses between forms of abnormal colour.

(2) To ascertain if any genetic association exists between uredinial colour and pathogenicity.

Historical Summary

Within the last year, several investigators have shown that physiologic forms of *Puccinia graminis* can hybridize upon the barberry. Waterhouse

(*9*) reported the origin of two new Australian forms of *Puccinia graminis tritici*, which resulted from crosses between two known physiologic forms. Stakman, Levine and Cotter (*8*) succeeded in crossing *Puccinia graminis agrostis* and *Puccinia graminis tritici* form 36. Newton, Johnson and Brown (*5, 6*) recorded the results of four crosses between physiologic forms of *Puccinia graminis tritici*, and by means of selfing eight different forms studied the breeding behaviour of these forms with respect to colour and pathogenicity.

Although these publications appear to be the first records of experimental hybridization in the rust fungi, a considerable amount of work has been done on hybridization in other fungi. Kämmerling (*3*), working with the stripe smut of *Glyceria* species, found that *Ustilago longissima* and *Ustilago longissima* var. *macrospora* hybridize in nature. These smuts occur commonly in the same locality, but usually on different plants. In the neighborhood of Rostock, he found plants which bore sori of both pure *longissima* and pure *macrospora*, and a few plants with mixed sori of both fungi. The spores from the mixed sori were intermediate both in shape and in manner of germination between the two varieties. He succeeded in making two crosses between the *longissima* and the *macrospora*. From these crosses he obtained a spore-form that was intermediate between the two parents in shape and manner of germination.

Goldschmidt (*2*) made six crosses between strains of the anther smut, *Ustilago violacea*, which he collected on the following host plants: *Dianthus carthusianarium, Melandryum album, Saponaria ocymoides, Saponaria officinalis, Silene saxifraga, Silene charantha*. The two strains of this fungus used in each cross differed in their infective capabilities, one strain could not infect the host plant of the other strain. From each cross arose, however, a first-generation hybrid which could infect both of the hosts from which the two parent strains had been cultured.

In all these hybridization experiments, the strains or forms of each cross were of the same colour, so that the inheritance of colour could not be studied. Crosses, however, have been made between forms which differ in colour. Zattler (*10*) crossed two varieties of *Collybia velutipes*, one with dark-brown mycelium and one with white mycelium. In the second generation there arose a dark-brown mycelial strain, two pale brown strains and a white strain. The white strain never gave rise to fruiting bodies.

Dodge (*1*), in a genetic study of *Neurospora*, was able to show that, when *N. sitophila*, which produces bright salmon pink conidia, was crossed with *N. tetrasperma*, which produces pale salmon pink to whitish conidia, monosporous mycelia derived from the first-generation ascospores developed large numbers of conidia of the *sitophila* parent type, namely, bright salmon pink. A sowing of the second-generation hybrid ascospores resulting from the combination of two mycelia (haplonts 8 and 9) gave rise to mycelial cultures, some of which produced bright salmon pink conidia, others pale salmon pink, and still others conidia that were intermediate in colour.

Although in other fungi, crosses have been made between forms which differ in colour, the crosses recorded in this paper appear to be the first that have been made between physiologic forms of different colours in any rust fungus.

Spore Colour of Parent Forms

Two distinct pigments are present in the urediniospores of *Puccinia graminis tritici,* one, an orange pigment in the cytoplasm, the other, a brownish pigment in the spore-wall. An investigation of the urediniospores of form 9*a* (orange) and form 36 (greyish-brown) has shown (*4*) that the urediniospores of the orange form lack the brownish pigment in the spore-wall, and that the urediniospores of the greyish-brown form lack the orange pigment in the cytoplasm. The urediniospores of form 52 (greyish-brown) are indistinguishable from those of form 36 (greyish-brown).

A difference in colour is readily noticeable in the spore-walls of the teliospores of the orange form and the greyish-brown forms. In the latter forms, as well as in forms of normal colour, the cell walls of the teliospores are dark-brown, while, in the orange form, the cell-walls of the teliospores are almost colourless (Figures 1 and 2). If any colour is present in the cytoplasm of teliospores of the greyish-brown and normal-coloured forms, it is completely masked by the dark-brown colour of the spore-walls. In the teliospores of the orange form, the cytoplasm is of a very pale yellow colour.

The aecia and aeciospores of the orange form do not differ visibly from those of the normal (red) forms, but the aecia and aeciospores of the greyish-brown forms are strikingly different. The aecia of the latter have a pale, bleached appearance, and the aeciospores, under the microscope, appear almost hyaline. Figure 3 illustrates well the contrast in colour between the aeciospores of a normal (red) form and those of a greyish-brown form. The dark colour of the cytoplasm in the normal aeciospores (upper chain) is due to the orange pigment which, in the greyish-brown aeciospores (lower chain), is absent. A brief summary of colour differences observed in the various spore-forms is given in Table 1.

Table 1.—*The colour differences observed in various spore forms of abnormally-coloured stem rust of wheat.*

	Urediniospores		Teliospores		Aeciospores
Form	Wall	Cytoplasm	Wall	Cytoplasm	
36 (greyish-brown)	Greyish-brown	Almost colourless	Dark brown	Not vislble	Almost colourless
52 (greyish-brown)	Greyish-brown	Almost colourless	Dark brown	Not visible	Almost colourless
9 (orange)	Almost colourless	Orange	Almost colourless	Very pale yellow	Orange
Normal (red) forms	Greyish-brown	Orange	Dark brown	Not visible	Orange

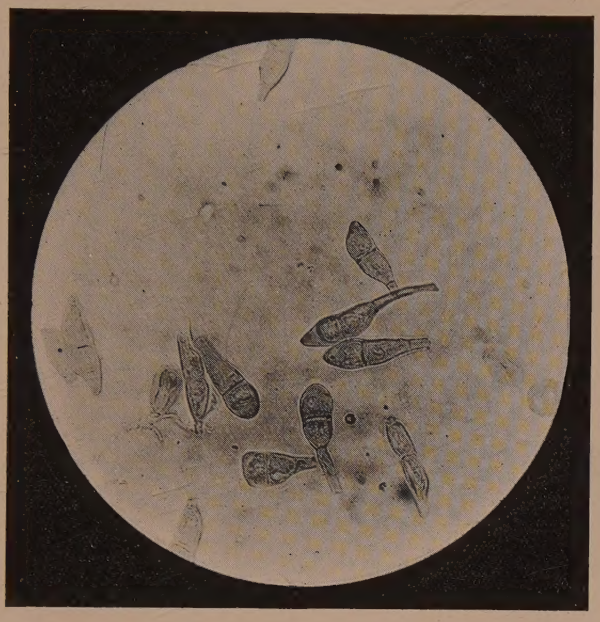

Figure 1. Photomicrograph of teliospores of form 9*a* (orange), showing lack of pigmentation in the spore-walls.

Figure 2. Photomicrograph of teliospores of form 36 (greyish-brown), showing pigmented spore-walls.

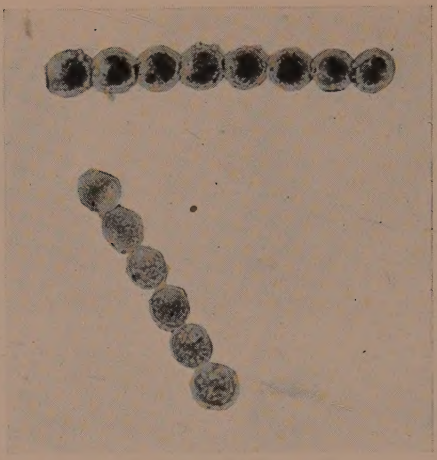

Figure 3. Photomicrograph showing aeciospore chains of form 9 (red), upper chain, and form 36 (greyish-brown), lower chain. The dark colour of the cytoplasm of the upper chain is due to orange pigment which is absent in the lower chain. A blue Wratten filter was used. Magnified x 355.

First-Generation Hybrids from Crosses Between Physiologic Forms of Abnormal Colour

The crosses made can be conveniently divided into four groups which will be referred to as I, II, III and IV. Group I includes all crosses made between physiologic forms 9*a* (orange) and 36 (greyish-brown). Group II consists of a cross between form 9 and form 15. Both forms were normal in urediniospore colour, but the cross is included in this paper on account of the appearance of spores of abnormal colour in the second hybrid generation .Group III comprises crosses between forms 9*a* (orange) and 52 (greyish-brown), and group IV, crosses between forms 14 (normal colour) and 36 (greyish-brown).

The technique employed in making the crosses was identical with that described in a previous publication (*6*). Barberry plants were inoculated with different physiologic forms, each individual form being used to inoculate one or more barberry plants. No barberry plant was inoculated with more than one form. The crossing was accomplished by transferring the pycnial nectar of monosporidial pustules produced by one form to monosporidial pustules produced by another form. The physiologic forms arising from the crosses were identified by means of the twelve differential wheat varieties selected by Stakman and Levine (*7*). Each uredinial culture originated from a single aecial cup. The aecial cups were picked off singly, crushed on a glass slide, and the spores of each cup used to inoculate one wheat seedling. Although from ten to fifteen cups were taken from each pustule, not all of them produced infection. The number of cultures, therefore, obtained do not necessarily represent the number of cups that were picked off.

Crosses Between Forms 9a (Orange) and 36 (Greyish-Brown)

The crosses between 9*a* (orange) and 36 (greyish-brown) are represented diagrammatically in Figure 5. The parent form 9*a* (orange) is homo-

zygous for both colour and pathogenicity, as is evident from Table 2 which shows the progeny resulting from the selfiing * of this form. This form differs from the true form 9 in its reactions on Marquis and Kota. The difference, however, is so slight that the form is designated as 9*a* rather than as a new form. Form 9 produces a (4) type of reaction on Marquis and Kota; form 9*a* (orange) produces on both hosts a (3–) type with chlorosis. The latter type of reaction on Marquis and Kota, when it appears in the progeny, will be referred to as the (3–)c type to distinguish it from the normal (4) type of reaction on these two varieties. The other parent form, 36 (greyish-brown), is homozygous for colour but heterozygous for pathogenicity. Its reaction on the varieties Marquis and Kota is of the (4) type and can easily be distinguished from that of the other parental form, form 9*a*. These two types of reactions are shown on Marquis in Figure 4.

TABLE 2.—*The genetic constitution, with respect to pathogenicity and colour, of the physiologic forms used in the crosses.*

Physiologic form	Forms isolated, with number of cultures of each in parenthesis	Number of forms isolated	Conclusions regarding pathogenicity
9	9 (40)	1	homozygous
9*a*	9*a* orange (13)	1	homozygous
36 greyish-brown	36 greyish-brown (12); 82 greyish-brown (2)	2	heterozygous
52 greyish-brown	52 greyish-brown (9)	1	homozygous
14	14 (3); 53 (3); 83 (1); E* (3)	4	heterozygous
15	Genetic constitution not yet known	—	—

*A new physiologic form.

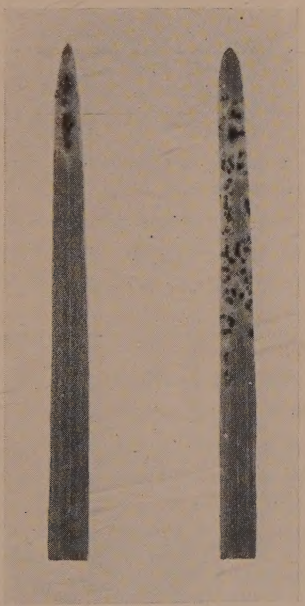

Figure 4. Reactions of seedling leaves of Marquis to hybrid forms 17 and 17*a*. The leaf on the left was infected by form 17 (reaction of the (4) type); that on the right, by form 17*a* (reaction of the (3–)c type).

*The term selfing refers to the intermixing of the nectar of the monosporidial pustules derived from the same physiologic form. This method was followed whenever it was desired to study the progeny of a single physiologic form.

The crosses are tabulated as I (a), I (b), I (c) and I (d). Each cross was made by a transfer of pycnial nectar from a pustule of one physiologic form to one or more pustules of the other physiologic form, and includes, in some cases, a reciprocal transfer of pycnial nectar, as in I (b) and I (c). The large figures in the first two columns represent the physiologic forms used in the crosses. The small figures in parenthesis refer to the monosporidial pustules from which, or to which, the pycnial nectar was transferred. The arrows connecting the first two columns of figures indicate the direction in which the pycnial nectar was transferred. For example, in cross I (c), pycnial nectar was transferred from pustule (5) on a barberry plant infected by form 36 to pustules (5) and (6) on a plant infected by form 9*a*. The figures in the column of squares represent the number of individual aecia that gave rise to uredinial cultures. Hence the figure 2 in the square opposite 9*a* (5), shows that each of the two aecia produced a uredinial culture; and the corresponding data in the last two columns show that each of these cultures was identified as form 17*a* of normal (red) colour.

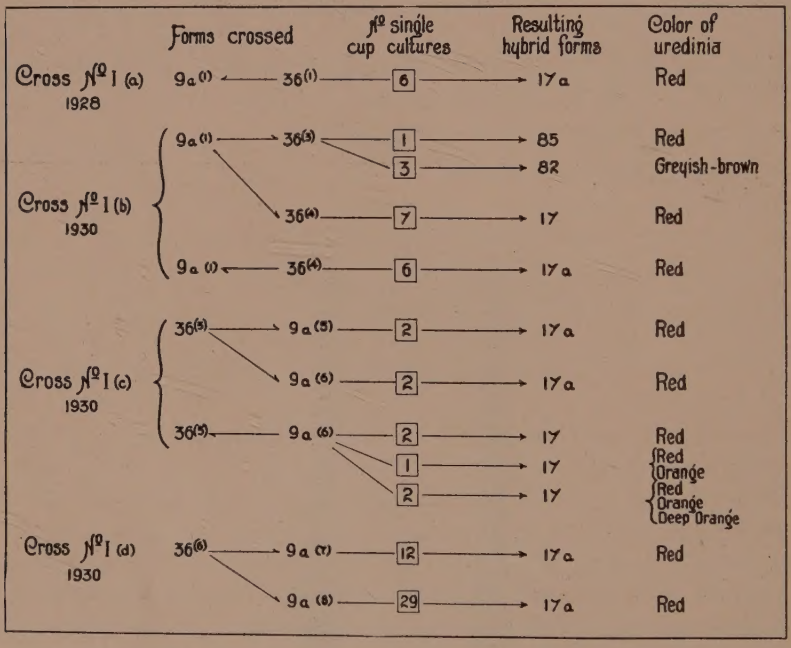

Figure 5. Crosses between form 9*a* (orange) and form 36 (greyish-brown). The figure includes, also, the physiologic forms appearing in the first hybrid-generation and the uredinial colour of the hybrid forms.

The uredinial stage of the first-generation hybrids from these crosses may be discussed in terms of (1) the colour of the urediniospores of the hybrid forms and (2) the pathogenicity of the forms.

It is apparent from an examination of the last column of Figure 5 that, when form 9*a* (orange) and form 36 (greyish-brown) are crossed, the urediniospores of the first-generation hybrid are, in most cases, normal

(red) in colour. Exceptions to this rule are found in crosses I (b) and I (c). In cross I(b), the aecia formed supposedly as a result of the cross 9*a* (1) x 36 (3)* gave rise to forms 85 (red) and 82 (greyish-brown). It is probable that, in this instance, the pustule 36 (3) was either not of monosporidial origin, but arose from (+) and (−) sporidia of form 36 (greyish-brown), or that nectar from a pustule of opposite sex of form 36 (greyish-brown) was transferred in some unknown way to pustule 36 (3). Hence the forms arising from its aecia would be traceable to two sources first, a cross between forms 9*a* (orange) and 36 (greyish-brown), which produced form 85 (red) and secondly, a selfing of form 36 (greyish-brown) which produced form 82 (greyish-brown). This explanation is supported by the fact that the last-mentioned form appears frequently when form 36 (greyish-brown) is selfed. The second discrepancy which is found in cross I (c) is more difficult to explain. Five aecia from the cross 9*a* (6) x 36 (5) produced uredinial cultures. The urediniospores of two of these cultures were normal (red) in colour. Some of the spores of the three remaining cultures, however, were orange in colour. Both rusts (orange and red), on identification, proved to be form 17. The fact that this was the first appearance of form 17 (orange) precludes the possibility that this rust arose as a contamination. At present, it seems most plausible to ascribe the origin of the orange rust to mutation.

The fourth column of Figure 5, shows that, with the exception of cross I (b), all the crosses between forms 9*a* (orange) and 36 (greyish-brown) resulted in uredinial hybrids which were identified as physiologic forms 17 or 17*a*. The pathogenicity of the latter form, as indicated by the differential varieties, differed so slightly from that of the true form 17 that the writers did not feel justified in describing it as a new physiologic form, but designated it as form 17*a*. These two forms differ only in their reactions on the varieties Marquis and Kota. Form 17 produces a (4) type of reaction on these hosts, and form 17*a* a (3–) type accompanied by sharp chlorosis. The reaction of these two hosts to form 17*a* is identical with their reaction to the orange form 9*a*, while their reaction to form 17 agrees with their reaction to form 36.

The significant fact concerning the occurrence of forms 17 and 17*a* is that, whenever the pycnial nectar of form 9*a* (orange) was transferred to pustules of form 36 (greyish-brown), form 17 was invariably recovered from the aecia of the form 36 (greyish-brown) pustules and that, conversely, whenever the pycnial nectar of pustules of form 36 (greyish-brown) was transferred to pustules of form 9*a*, form 17*a* was invariably recovered from the aecia of the form 9*a* pustules (e.g., crosses I (b) and I(c), Figure 5). In cross I (b), for example, 9*a* (1) x 36 (4) gave rise to form 17, and 36 (4) x 9*a* (1) to form 17*a*. This phenomenon offers some difficulty to an interpretation of the inheritance of pathogenicity on a strictly Mendelian basis. If the chromosomes alone are concerned with the inheritance of pathogenicity, it would be expected that the same physiologic form would arise from the two sides of a cross made in both directions.

*In all cases in which a cross is recorded in this manner, the pycnial nectar was transferred from the first-mentioned to the last-mentioned pustule—in this instance, from pustule 9*a* (1) to pustule 36 (3).

TABLE 3.—*Mean reactions produced by parent and hybrid physiologic forms of Puccinia graminis tritici on the differential varieties of Triticum spp.*

Physiologic form	L.C.	Ma.	Krd.	Ko.	Arn.	Mnd.	SpM.	Kub.	Ac.	Enk.	Ver.	Kpl.
1	4	4−	0	3+	1=	1	1=	3+	3++	3	0;	1=
9	4	4−	0	3++	4−	4=	4=	4=	3++	3+	4=	1−
11	4−	4=	3++	3+	4=	4=	4=	3++	3++	3	1=	1=
14	4+	2−	1−	1++	3++	3++	3++	3++	3++	3	1=	0;
15	4	4−	4=	3++	4=	4=	4=	3++	3++	3+	4=	1=
17	4	4−	0	3+	4=	4=	4=	3++	3++	3	1=	1=
36	4	4	4−	3++	1=	1=	0;	×	3++	3	0;	1−
52	4	4	4−	4	1=	1=	1=	3++	4	4−	4+	1−
57	4	4−	0	4−	1	1	1	3+	4−	3+	3+	1
82	4	3+	3+	3+	0;	0;	0;	×	3+	3+	×	1
85	4	4−	0	3±	4−	4	4	4	4	3+	×	1
88	4	×	0	1±	4	4	4	4	4	3+	1	1

Apparently the results cannot be explained on a Mendelian basis alone. If it is assumed, however, that the cytoplasm of the maternal pustule—the one to which the pycniospores of the other parental pustule are applied—also contributes to the inheritance of pathogenicity, a plausible explanation can be reached. One of the above-mentioned crosses, I (b), may be taken as an example. The pycniospores from pustule 9*a* (1) were transferred to pustule 36 (4), the maternal pustule. It would then be expected that, as the nuclei of the pycniospores of pustule 9*a* (1) and the nuclei of the haploid hyphae of pustule 36 (4) contribute equally to the inheritance of the hybrid, the additional inheritance from the cytoplasm of pustule 36 (4) would cause the hybrid form, form 17, to resemble in pathogenicity form 36 more than form 9*a*. For the same reason, when the pycniospores of pustule 36 (4) were transferred to pustule 9*a* (1), it would be expected that the hybrid form, form 17*a*, would resemble form 9*a* in pathogenicity more than form 36. A comparison of the reactions of forms 36 and 17 on Marquis and Kota (Table 3) shows that there is striking similarity between these two forms. Likewise, a comparison of the reactions of forms 9*a* (orange) and 17*a* on the same two varieties shows that these two forms are strikingly similar. The most plausible explanation of the resemblance of these two hybrid forms to what may, perhaps, be called their "maternal" parents is to be found in maternal cytoplasmic inheritance.

Although this appears to be the first instance of cytoplasmic inheritance in the rusts, its occurrence in other fungi has been recorded. Goldschmidt (*2*) reports a case of this type of inheritance in a hybrid between two forms of *Ustilago violacea* Pers. According to Goldschmidt (*2*), Harder reports another case in a haploid strain of *Pholiota* sp. In both these instances, the influence of the cytoplasm of haploid strains, as expressed in the hybrids between them, is directly proportional to the amount of cytoplasm transmitted to the hybrid.

A Cross Between Forms 9 (Red) and 15 (Red)

This cross, which was made in the spring of 1929 between two physiologic forms of normal (red) urediniospore colour, produced first-generation uredinial cultures which were identified as physiologic form 9 (Figure 6). The cross was made in both directions, 9 (1) x 15 (1) and 15 (1) x 9 (1). The resulting hybrid forms, from both sides of the cross, were identical with each other and with the form 9 parent in respect to pathogenicity on the differential hosts. The pathogenic characters of form 9 are evidently dominant over those of form 15.

The appearance of physiologic form 9 from this cross is interesting, especially in view of the fact that the form 9 parent was known to be homozygous for pathogenicity factors (Table 2). The inheritance of the pathogenicity of the form 15 parent has not been studied. If this parent form were homozygous for pathogenicity factors, the hybrid form 9 would of course, be in a heterozygous condition and, in that case, would be genetically different from the parent form 9, although identical with it in host reaction. If the form 15 parent were heterozygous for pathogenicity, it is possible, although not probable, that the hybrid form 9 might be homozygous. To determine

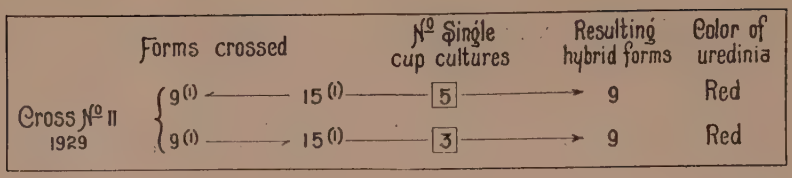

Figure 6. Crosses between form 9 and form 15, both of normal (red) urediniospore colour. The figure includes, also, the physiologic forms appearing in the first hybrid generation and the uredinial colour of the hybrid forms.

whether the hybrid form 9 was homozygous or heterozygous for pathogenicity, a further study was made of its inheritance. This study is discussed in the section dealing with the second-generation hybrid forms.

Crosses Between Forms 9a (Orange) and 52 (Greyish-Brown)

The results of crosses between the two forms, 9*a* (orange) and 52 (greyish-brown), are presented in Figure 7. Form 52 (greyish-brown) resembles form 36 (greyish-brown) in its pathogenicity on all the differential hosts except Vernal emmer (*Vide* table 3).

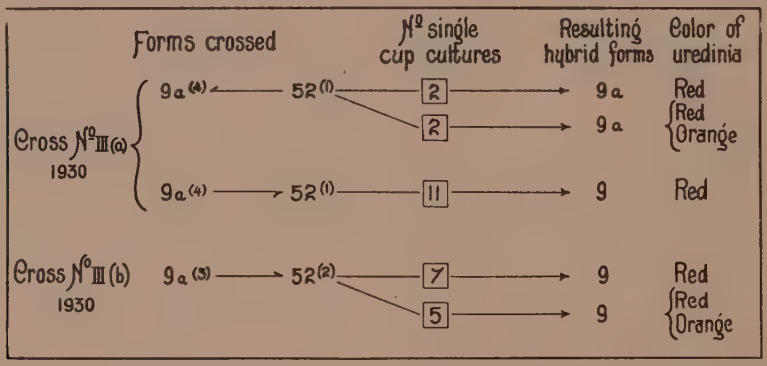

Figure 7. Crosses between form 9*a* (orange) and form 52 (greyish-brown). The figure includes, also, the physiologic forms appearing in the first hybrid generation and the uredinial colour of the hybrid forms.

With two exceptions, these crosses resulted in uredinial hybrids of normal (red) colour. One exception occurred in cross III (a) (Figure 7). Two cultures produced both red and orange urediniospores of form 9*a*. As these cultures were derived from pustule 9*a* (4) the orange spores may have originated through accidental selfing of form 9*a* (orange). The other exception occurred in cross III (b), from which twelve uredinial cultures were obtained. Seven of these were normal in spore colour, but five contained some orange spores among the normal (red) spores. For this departure from the normal colour, as in the colour aberration which occurred in the hybrids from the cross 9*a* (orange) x 36 (greyish-brown), no explanation can be offered except that of mutation.

All the uredinial cultures of the hybrid were identified as either form 9 or form 9*a*. The pathogenic characters of form 9 are dominant over

those of form 52. The hybrid form 9*a* appeared only in the cross III (a) in which the pycnial nectar was transferred from pustule 52 (1) to pustule 9*a* (4) and the aecia developed in the latter pustule. In the reciprocal cross, in which the pycnial nectar was transferred from pustule 9*a* (4) to pustule 52 (1), the uredinial hybrid was a characteristic form 9. Form 9 also was recovered from the other cross, III (b), which was made in the same direction. Evidently this cross affords another instance of cytoplasmic influence on the inheritance of pathogenicity.

Crosses Between Forms 14 (Red) and 36 (Greyish-Brown)

In these crosses (Figure 8), form 14, of normal (red) colour, was crossed with form 36 (greyish-brown). The urediniospores of the first-generation hybrid were all normal (red) in colour, as were those of the form 14 parent.

The two parent forms differ widely in their pathogenicity on the differential hosts, as shown in Table 3. The varieties Marquis and Kota are resistant to form 14 but susceptible to form 36. The durum varieties, Arnautka, Mindum, and Speltz Marz, are susceptible to form 14 but resistant to form 36. Kanred is immune to form 14 but susceptible to form 36.

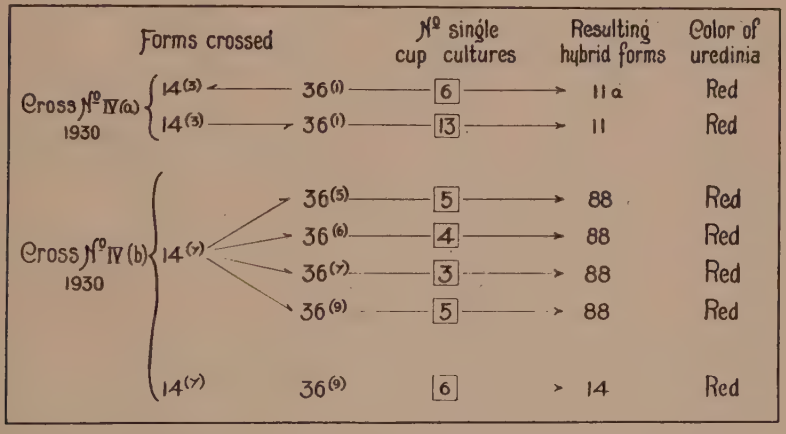

Figure 8. Crosses between form 14 (red) and form 36 (greyish-brown). The figure includes, also, the physiologic forms appearing in the first hybrid generation and the uredinial colour of the hybrid forms.

From these crosses, four different forms were recovered, namely, forms 11, 11*a*, 88, and 14. Form 11 originated from cross IV (a), 14 (3) x 36 (1) and form 11*a*, from the reciprocal cross, 36 (1) x 14 (3). The difference between forms 11 and 11*a* consists in the reaction of Marquis on which form 11 produces a (4) type and form 11*a* a (3–) type with sharp chlorosis. This is, apparently, another case of cytoplasmic influence on the inheritance of pathogenicity.

Form 88 arose as a result of the transfers of pycnial nectar from pustule 14 (7) to pustules 36 (5), (6), (7) and (9). The aecia, of course, developed in the form 36 pustules to which the nectar from pustule 14 (7) was applied. In the reciprocal cross, where the pycnial nectar of pustule 36

(9) was transferred to pustule 14 (7), the resulting hybrid was a typical form 14. Form 88 differs from form 14 only in its reaction on Marquis. On this host form 88 produces an (X) type of reaction, while form 14 produces a (1) type. This is evidently another case of cytoplasmic inheritance of pathogenicity.

The fact that physiologic forms of markedly different pathogenicity arose from the crosses IV (a) and IV (b) can be accounted for by the heterozygous condition of the form 14 parent (*cf.* Table 2).

Second-Generation Hybrids from Crosses Between Physiologic Forms

The second-generation hybrids were obtained by selfing the first-generation hybrid forms. The production of a second-generation hybrid from one of the first-generation involves passing the rust through its complete life-cycle, from uredinial stage to uredinial stage. This cycle embraces the formation and germination of teliospores, the infection of the alternate host (barberry) with the sporidia, the selfing (intermixing of the pycnial nectar), and the formation of the aecia from which the second uredinial generation is obtained. The uredinial cultures were, in all cases, established by the use of individual aecia which were selected at random from large numbers of aecial pustules. By this method of random sampling, it was hoped to obtain a group of uredinial cultures which would be representative of the second-generation hybrid population.

Only the hybrids from crosses I (a) and II were studied in the second generation. The hybrids from cross I (a), form 36 (greyish-brown) x form 9*a* (orange), will be considered first.

Second-Generation Hybrids from Cross I (a), between Form 36 (Greyish-Brown) and Form 9a (Orange)

The first-generation hybrid between these two physiologic forms was identified as form 17*a* and was of normal urediniospore colour (Figure 5). In the second generation, one hundred and twenty-six uredinial cultures, arising from individual aecial cups, were studied for urediniospore colour and pathogenicity on the twelve differential hosts. Observations were made on one hundred and thirty-five cultures for urediniospore colour. The one hundred and twenty-six cultures studied for pathogenicity were resolved into one or another of seven different physiologic forms. The one hundred and thirty-five cultures studied for urediniospore colour fell into four distinct colour groups: red, orange, greyish-brown and white (Table 4). There was some variation in uredinial colour among cultures in the red group. The spores of the majority of these cultures were normal (red) in colour and correspond closely to the "amber brown", on Plate III of Ridgway's Colour Standard. Two cultures, however, were classified as "antique brown". The urediniospores of the orange cultures correspond to "orange", and are identical with those of the grand-parental form 9*a* (orange). The spores of the greyish-brown cultures correspond to the spores of the grand-parental form 36 (greyish-brown) and to "Prout's brown," on Plate XV. The spores of the white cultures are creamy-white in appearance when the uredinia first appear, but assume a light buff colour after the uredinia have been exposed

to sunlight for several days. This colour corresponds to Ridgway's "ochraceous buff", on Plate XV.

The observed frequencies in the distribution of the one hundred and thirty-five cultures among the four colour groups are recorded in Table 4. For comparison, there are included in this table frequencies calculated on the assumption that two independently inherited factors are necessary for normal urediniospore colour. The actual frequencies agree rather closely with the theoretical ones in the greyish-brown and white groups, but there are wide divergencies between the observed and the theoretical frequencies in the red and orange groups. The possible reasons for these discrepancies are discussed in another part of this paper.

TABLE 4.—*A comparison between observed frequencies of second-generation hybrids from cross I (a) in the four colour classes and frequencies calculated on the basis of a 9:3:3:1 ratio.*

Urediniospore colour	Red	Orange	Greyish-brown	White
Observed frequencies	59	47	22	7
Calculated frequencies	75	25	25	8.3

As already stated, one hundred and twenty-six second-generation hybrid cultures were studied for pathogenicity on the twelve differential wheat varieties. These cultures were identified as one or another of seven physiologic forms, namely, 1, 11, 15, 17, 36, 57 and 85 (Table 6). Only one of the grand-parental forms, form 36 (greyish brown), appeared again in the second generation. Four of these forms, namely, 1, 11, 17, and 36, were of two types, with respect to their reaction on the varieties Marquis and Kota, and are, in consequence, referred to as 1 and 1*a*, 11 and 11*a*, 17 and 17*a*, 36 and 36*a* (Table 5). The reactions of these two hosts to the forms designated by the letter *a* resemble their reactions to the grand-parental form 9*a*, and the first-generation hybrid 17*a* from which these forms are descended. The reactions of Marquis and Kota to all the second-generation hybrid forms not designated by the letter *a* are similar to their reactions to the other grand-parental form, 36 (greyish-brown). Both these types of reactions appeared in the first-generation hybrids of the crosses between form 9*a* (orange) and 36 (greyish-brown), and were ascribed to cytoplasmic influences on inheritance.

In the second-generation hybrids, these two reaction-types were not always so distinct as they were in the hybrids of the first generation. Some of the hybrid reactions appeared to be somewhat intermediate between the two types, but were, in all cases, classified as one or the other type. The distribution of these types of reactions among the physiologic forms in the different colour groups is of interest. Table 5 shows that the majority of the cultures of the red colour-group are not of the *a* type, in other words, they are, for the most part, similar to the grand-parental form, 36 (greyish-brown), with regard to the reactions of Marquis and Kota. This is particularly noticeable in the case of form 17, of which twenty-five cultures were classified as a true form 17—Marquis and Kota reaction of

TABLE 5.—*The characteristics of the second-generation hybrids of cross I (a), form 9a (orange) x form 36 (greyish-brown), with respect to urediniospore colour and physiologic form identity.*

Physiologic forms	Colour of urediniospores			
	Red	Orange	Greyish-brown	White
1	4	3	2	1
1*a*	5	5	1	1
11	9	2		1
11*a*	1	2		
15	1			
17	25	2	2	
17*a*	6	30	2	2
36			5	
36*a*	1		8	
57*a*	1			
85	1	1	1	1
Total number of hybrids	54	45	21	6

the (4) type—and six cultures as form 17*a*—Marquis and Kota reaction of the (3–)c type. In the orange colour-group, on the contrary, the (3–)c type of reaction predominates. In this respect the orange group resembles the grand-parental form 9*a*. Thirty cultures, for example, are classified as form 17*a* and two cultures as a true form 17. In the greyish-brown and the white groups, these two types of reactions occur with approximately equal frequency.

There is evidently a relationship between orange urediniospore colour and the (3–)c type of reaction. If, as seems probable, the inheritance of this type of reaction is influenced by the cytoplasm, is it possible that the inheritance of the orange colour is also influenced by the cytoplasm? If this were the case, there should be no orange colouring matter in the spores of the first-generation hybrid from a cross made in the opposite direction from the cross now under discussion, that is, one in which the pycnial nectar was transferred from a pustule of form 9*a* (orange) to one of form 36 (greyish-brown) and the aecia developed in the latter pustule. Two such crosses were made, crosses I (b) and I (c), and in both crosses the urediniospores of the first-generation hybrids were normal (red) in colour. This colour involves the presence of orange pigment in these spores, which, together with the brownish pigment of the spore-walls, produces the characteristic red colour of the spores when viewed in mass. The orange pigment is therefore present, but, although it appears to be linked in some way with the (3–)c type of rust reaction, it is not inherited through the cytoplasm.

The possibility of genetic linkage between urediniospore-colour and pathogenicity had occurred to the writers as a result of observations made before this work was undertaken. At that time, only three physiologic forms of abnormal spore-colour were known, namely, forms 9*a* (orange), 36 (greyish-brown) and 52 (greyish-brown). The two last-mentioned forms, as stated above, have occurred frequently from infections caused on barberry plants by teliospores collected in nature. No other forms of abnormal spore-colour, however, were obtained from these collections, although sev-

eral other forms of normal spore-colour were identified. This suggested that there might be a genetic linkage between greyish-brown spore-colour and pathogenicity.

As far as the cross under discussion is concerned, there seems to be some evidence of such an association. Table 5 shows that fourteen cultures of second-generation hybrids were identified as form 36 or form 36*a*. The urediniospores of thirteen of these cultures were greyish-brown in colour. But, in all the other hybrid forms, there is no evidence of association between colour and pathogenicity, excepting the case already mentioned of the association between orange spore-colour and the (3–)c type of reaction on Marquis and Kota. Forms 1, 17 and 85 appear in all the colour groups. Form 11 appears in the red, orange and white groups. Forms 15 and 57 appear only once, and are in the red group.

An attempt to find a factorial basis for the pathogenic behaviour of the second-generation hybrids meets with certain difficulties. If the slight differences between the two types of each form are disregarded, *e.g.*, differences between form 1 and form 1*a*, each physiologic form can be considered as a class, and the number of cultures of each form as the frequencies in each class. A classification of this kind is found in Table 6. The distribution suggests a tri-hybrid ratio, but fails to approximate it closely enough to allow a three-factor basis to be established. The smallness of the hybrid population studied accounts, perhaps, for the lack of agreement with any known genetic ratio.

TABLE 6.—*A comparison between observed frequencies of physiologic forms in the second hybrid generation of cross I (a), and frequencies calculated on the basis of a 27:9:9:9:3:3:3:1 ratio.*

Physiologic forms	17	1	36	11	15	85	57	
Observed frequencies	69	22	14	15	1	4	1	0
Calculated frequencies	54	18	18	18	6	6	6	2

It is difficult to explain the occurrence in the second generation of two distinct types of reaction on Marquis and Kota, corresponding to the reactions of the two grand-parental forms, 9*a* and 36. If these reactions were inherited in a Mendelian manner, they would be expected to reappear in the second generation. There is evidence, however, that in the first generation they were not thus inherited, but were due to the influence of the cytoplasm. The reaction on Marquis and Kota of the first-generation hybrid from the cross I (a) was identical with the reaction of the maternal parent form 9*a* (orange). As this type of reaction was evidently transmitted to the first-generation hybrid by the cytoplasm of the maternal parent form, it would be expected to the exclusion of all other types of reaction in the second generation. Actually, only sixty-five of the one hundred and twenty-six second-generation hybrids produced this reaction; the remaining sixty-one hybrids resembled the other grand-parental form, 36 (greyish-brown),

more closely in their reactions on Marquis and Kota. No satisfactory explanation of these results can at present be put forward.

Second-Generation Hybrids from Cross II, Form 9 (Red) x Form 15 (Red)

The cross between forms 9 and 15, as already stated, was made in both directions, 9 x 15 and 15 x 9, and the first-generation hybrids were identified as physiologic form 9. The second-generation hybrids studied were, however, derived from one side of the cross, form 9 x form 15, in which the pycnial nectar was transferred from a pustule of form 9 to a pustule of form 15 and the aecia developed in the latter pustule.

As a result of selfing the first-generation hybrid, aecia were produced which were of two distinct colour-types. Some of the pustules produced normal (orange-coloured) aecia, others produced whitish aecia. A few pustules contained aecia of both colour-types. The spores of the whitish aecia showed, on microscopic examination, either a total absence of yellow colour in the cytoplasm, or only a faint trace of it.

In the second-generation hybrids, the urediniospores were of two distince types with respect to colour. The hybrids obtained from aecia of normal colour produced urediniospores of normal colour. Those obtained from the whitish aecia produced urediniospores of greyish-brown colour. Uredinial cultures from fourteen of the normal aecia and eleven of the whitish aecia were studied for colour and pathogenicity on the twelve differential hosts.

The appearance of greyish-brown second-generation hybrids from a cross between two physiologic forms of normal spore colour is of interest. This phenomenon can be explained, however, on the assumption that one or the other of the grand-parental forms was heterozygous for the factors responsible for greyish-brown colour. The grand-parental form 9 was evidently homozygous for colour (Table 2), since the progeny which resulted from selfing this form was all of normal colour. The other grand-parental form, form 15, was, unfortunately, not studied in this connection owing to the fact that its teliospores stopped germinating soon after the cross was made. If it is assumed that this form was heterozygous for the factors determining greyish-brown colour, it is evident that a greyish-brown rust would be expected in the second-generation hybrids of the cross between forms 9 and 15.

The second-generation hybrids were studied for pathogenicity and were resolved into four different physiologic forms, as shown in Table 7. Some of the hybrids of red spore-colour were identical in pathogenicity with the grand-parental forms 9 and 15. Of the two other forms which appeared, namely, forms 85 and 57, the former is very similar to form 9, differing from it only in its reaction on Vernal emmer. Form 85 produces an (X) type of reaction on this host, while form 9 produces a (4) type. In the reactions of form 57, there is evidence of transgressive segregation. This form produces a (1) type of reaction on the varieties Arnautka, Mindum, and Speltz Marz. Both the grand-parental forms produced a (4) type on these varieties.

The eleven cultures of greyish-brown spore colour, which were studied for pathogenicity, were identified as one or another of two physiologic forms, namely 85 and 15 (Table 7). The preponderance of form 85 (nine of the eleven cultures correspond to this form) indicates that there is some association between pathogenicity and spore-colour. Furthermore, there is a slight difference in colour between the greyish-brown form 85 and the greyish-brown form 15. The urediniospores of the former were classified according to Ridgway's Colour Standards as "Prout's brown", on Plate XV, and those of the latter as "Mars brown".

TABLE 7.—*The classification of the second-generation hybrids of cross II (form 9 x form 15) on the basis of their pathogenicity on the twelve differential hosts and urediniospore colour.*

Physiologic form	9	85	57	15
Cultures producing red urediniospores	7	3	3	1
Cultures producing greyish-brown urediniospores		9		2

In the second-generation, the number of cultures studied is too small to permit any statement concerning a factorial basis for pathogenicity. The fact that the cultures of red uredinial colour fall into four classes on the basis of pathogenicity, and the numerical distribution of the cultures in these classes suggest the presence of two pairs of factors determining pathogenicity. The ratio obtained, namely, 7:3:3:1, is also suggestive of a 9:3:3:1 ratio. If the cultures of greyish-brown rust are included, this ratio is not approximated. These cultures may, perhaps, be left out of consideration on account of the apparent association between colour and pathogenicity. A further study of this cross is necessary before any definite conclusions can be reached concerning a factorial basis for pathogenicity.

DISCUSSION

The primary object of the investigations reported in this paper was a study of the inheritance of colour in stem rust. This was made possible through the presence of certain physiologic forms of abnormal colour. Studies of first and second generation progeny of crosses between these forms have revealed a number of interesting facts regarding the inheritance of colour, and have, also, raised a number of questions which, at present, it is not possible to answer fully.

The normal (red) colour of the urediniospores of stem rust, when viewed in mass by the naked aye, is the combined effect of two distinct types of pigments present in the spores, an orange pigment located in the cytoplasm, and a pigment of a brownish colour present in the spore-wall. Two of the authors (*4*) have shown that the orange pigment is of a carotinoid nature, but they were unable to determine the chemical nature of the other

pigment. If the orange pigment alone is present in the spores, the latter, when viewed in mass, appear orange, if the brownish pigment alone is present the spores, in mass, appear greyish-brown.

It seemed probable that, if an orange form was crossed with a greyish-brown form, the resulting hybrid would be normal in spore colour. This epectaton was fulfilled, with a few exceptions.

If the inheritance of colour in stem rust has a Mendelian basis, it would be expected that these two colour-types would reappear in the second-generation hybrids. This expectation, also, was fulfilled. The second-generation hybrids were of four different colour-types, red, orange, greyish-brown and white. This segregation suggests that two pairs of factors are necessary for normal urediniospore colour. If one of these pairs is present in the homozygous recessive condition, the colour of the urediniospores would be either orange or greyish-brown, depending on which pair of factors is in the recessive condition. If both pairs of factors are in the recessive condition, the spores would lack both pigments and would be colourless, or whitish in appearance.

Stem rust appears to be commonly homozygous for both these colour factors. Hence the occurrence of strains of abnormal colour is comparatively rare. Of the eight physiologic forms, the breeding behaviour of which was previously studied (*6*), only two proved to be heterozygous for colour factors. These two forms, 36 and 52, produced a few cultures of greyish-brown uredinial colour. A number of collections of teliospores have also given rise to cultures of forms 36 and 52 of greyish-brown colour. The fact that in no other forms has the greyish-brown colour been found suggests that there may be some relationship (perhaps genetic linkage) between the pathogenicity factors of forms 36 and 52 and the factors for greyish-brown urediniospore colour. This suggestion is borne out, with respect to form 36, by the results in the second hybrid generation of the cross between 9*a* (orange) and 36 (greyish-brown). Table 5 shows that fourteen cultures of form 36 appeared in this generation. Thirteen of these were greyish-brown in urediniospore colour. As this distribution can hardly be a matter of chance, it indicates an association between the factors responsible for the development of greyish-brown colour and those governing the host reaction of form 36.

A somewhat similar relationship is found between pathogenicity and urediniospore colour in the second generation hybrids of the cross between forms 9 and 15. Both forms were normal in spore colour, but there is some circumstantial evidence that form 15 was heterozygous for the factors determining greyish-brown colour. In the second generation, there appeared cultures of normal and of greyish-brown colour. The distribution of physiologic forms in the greyish-brown hybrid group was, however, quite different from that in the red hybrid group (Table 7). Eleven cultures of greyish-brown hybrids were studied, nine of which were classified as form 85. Fourteen cultures of red hybrids were studied, of which only three were identified as form 85. Evidently there is, in this instance, an association between form 85 pathogenicity and greyish-brown colour.

The above examples of association between colour and pathogenicity may, perhaps, be explained as cases of true genetic linkage. There appears, however, to be another type of association between colour and pathogenicity which cannot be thus explained, namely, the frequent association between orange urediniospore colour and the so-called (3–)c type of reaction on the varieties Marquis and Kota in the second hybrid generation of the cross between form 9*a* (orange) and 36 (greyish-brown). This association can be discussed more satisfactorily after the inheritance of the (3–)c type of reaction has been considered.

The (3–)c type of reaction, (3–) with chlorosis, is the characteristic rust reaction of the parent form, 9*a* (orange), on Marquis and Kota. When these two varieties are infected by the other parental form, form 36 (greyish-brown), the reaction is of the (4) type. In all the crosses which gave rise to aecia in pustules of form 9*a*, as a result of the transfer to them of pycnial nectar from pustules of form 36, this characteristic reaction appeared in the first generation hybrid forms derived from these aecia. In the hybrid forms derived from the other side of the crosses (in which the aecia arose in pustules of form 36 as a result of the transfer to them of nectar from pustules of form 9*a*), the reaction of Marquis and Kota was not of the (3–)c type but approximated very closely the reaction of these hosts to the form 36 parent. Apart from these differences on Marquis and Kota, the hybrid forms from the two sides of these crosses were identical. If pathogenicity is inherited in a Mendelian manner, the hybrid forms on both sides of the cross should be absolutely identical. Since they are not, it must be postulated that some other type of inheritance plays a part. The assumption that the cytoplasm of the maternal parent form—the form to which pycnial nectar was transferred—affects the pathogenicity of the hybrid seems to afford a satisfactory explanation of these results with respect to the first-generation hybrids. In the second-generation of the cross I (a), form 36 (greyish-brown) x form 9*a* (orange), there is a gradation from the (3–)c type of reaction on Marquis and Kota which is characteristic of one grand-parental form to the (4) type characteristic of the other. This is rather surprising as the first-generation hybrid was identified as form 17*a* with a typical (3–)c reaction on these two hosts. Since this type of reaction appears to be inherited by means of the cytoplasm in the first generation, it would be expected in all the hybrids of the second generation. Actually it appears only in about one-half of the hybrids, as shown in Table 5. These figures, however, are more or less arbitrary because of the gradations of one type into another. Further work is necessary before this type of inheritance can be satisfactorily explained.

Similarly, the association between orange urediniospore colour and the (3–)c type of reaction in the second generation can not at present be explained. Of the forty-five second-generation hybrids of orange colour, thirty-seven were characterized by the (3–)c type of reaction, and, in this respect, resembled the orange grand-parental form.

A factorial basis for the inheritance of pathogenicity can not, at present, be established. For this purpose, further crosses and larger hybrid popula-

tions are necessary. The cross between forms 9 and 15 suggests the possibility of a two factor basis, while the cross between forms 36 (greyish-brown) and 9*a* (orange) suggests a three factor basis, but the ratios obtained do not permit any definite conclusion.

The question of the inheritance of the colour and pathogenicity characters of physiologic forms appears to be rather complicated. Studies on the inheritance of pathogenicity may be further complicated by the inadequacy of differential-host reaction as an index of genotype. There is evidence that cultures of the same physiologic form, obtained from different sources, may be genotypically different. In this paper the writers have made mention of three different cultures of physiologic form 9 of normal colour, which may represent three different genotypes. One of these cultures is definitely known to be homozygous, another is a hybrid between it and form 15 and is heterozygous for colour and pathogenicity, the third is a hybrid between form 9*a* (orange) and form 52 (greyish-brown), but its genetic constitution is as yet unknown. These three cultures are identical in rust reaction on the differential hosts although they differ in genetic constitution.

It is manifest from these observations that the inheritance of colour and pathogenicity is apparently quite complex, and its analysis is further complicated by the inadequacy of the present means of study. Further studies will, however, undoubtedly throw light on many questions concerning inheritance, which at present are imperfectly understood.

Summary

1. A study has been made of the inheritance of colour and pathogenicity characters in crosses between physiologic forms of *Puccinia graminis tritici* of abnormal colour.

2. Crosses between form 36 (greyish-brown) and form 9*a* (orange) in which pycnial nectar was transferred from pustules of the former to pustules of the latter, gave rise to form 17*a*, of normal (red) urediniospore colour. Two crosses between the same two forms, made in the opposite direction—the pycnial nectar was transferred from pustules of form 9*a* (orange) to pustules of form 36 (greyish-brown)—gave rise to physiologic form 17 of red urediniospore colour. The two hybrid forms, 17 and 17*a*, differ only in their reactions on the varieties Marquis and Kota. Form 17 produces a (4) type on these varieties, and form 17*a* a (3–) type with chlorosis. In these crosses, a form to which pycnial nectar of another is applied is designated as the "maternal" parent form. In all the crosses, with the exception of those between forms 9 and 15, the maternal parent form modifies the pathogenicity of the hybrid by impressing on it some of its characters. Its pycniospores, however, do not apparently transmit these characters. Thus the hybrid resembles the maternal parent form more than the other parent form. This phenomenon is most satisfactorily accounted for by cytoplasmic or maternal inheritance.

3. A cross, in both directions, was made between forms 9 and 15 of normal (red) urediniospore colour. The first-generation hybrids, from both sides of the cross were red in urediniospore colour and were identified as physiologic form 9. The pathogenic characters of form 9 are dominant over those of form 15.

4. Crosses were made in both directions between form 9*a* (orange) and form 52 (greyish-brown). The first-generation hybrids from the cross 9*a* (orange) x 52 (greyish-brown)—the pycnial nectar was transferred from pustules of form 9*a* to pustules of form 52—were identified as form 9 of normal (red) colour. The hybrids from reciprocal crosses, 52 x 9*a*, were identified as form 9*a* of normal (red) colour. This difference in pathogenicity between the hybrids is attributed to cytoplasmic inheritance.

5. Crosses were made in both directions between form 14 (red) and form 36 (greyish-brown). All the first-generation hybrids were normal (red) in colour. The hybrids from the crosses made in one direction, form 14 (red) x form 36 (greyish-brown) were identified as form 11 and form 88; those from the reciprocal crosses, 36 (greyish-brown) x form 14 (red), were identified as form 11*a* and form 14. These differences between the hybrid forms afford another instance of cytoplasmic inheritance.

6. With a few exceptions, the first-generation hybrids from crosses between forms of abnormal colour were normal (red) in urediniospore colour. These exceptions occurred in the crosses between forms 9*a* (orange) and 36 (greyish-brown), and the crosses between forms 9*a* (orange) and 52 (greyish-brown). Some of the hybrids from these crosses were orange in spore colour. This phenomenon can not be accounted for, except by mutation.

7. The second-generation of the cross, 36 (greyish-brown) x 9*a* (orange), was studied with regard to the colour of the hybrids, and their pathogenicity on the differential hosts. The hybrids fell into four distinct colour-groups, red, orange, greyish-brown and white. The second-generation hybrids were identified as one or another of seven different physiologic forms, namely, 1, 11, 15, 17, 36, 57 and 85. Neither the inheritance of colour nor the inheritance of pathogenicity can, at present, be placed definitely on a factorial basis, although the distribution of the second generation hybrid forms suggests a trihybrid ratio.

8. The second generation of the cross, 9 (red) x 15 (red), was also studied with respect to the colour and pathogenicity of the hybrids. Some of the hybrids were greyish-brown in colour, thus indicating that one of the grand-parental forms, probably form 15, was heterozygous for the factors determining greyish-brown colour. The hybrids were identified as one or another of four physiologic forms, namely, 9, 15, 57 and 85. The population of second-generation hybrids studied was too small to permit a factorial basis to be established for the inheritance of either colour or pathogenicity.

9. There appears to be an association between colour and pathogenicity in some of the forms in the second generations of the crosses 36 (greyish-brown) x 9*a* (orange) and 9 (red) x 15 (red).

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PRESIDENTIAL ADDRESS

Presented at the Tenth Annual Convention of the C.S.T.A.

J. P. Sackville

University of Alberta, Edmonton, Alberta

A year ago, at the annual convention in Winnipeg, at which time I assumed the duties of President of the society, I appreciated the distinct honour that was associated with the office. At the same time, however, I realized that it envolved considerable responsibility. I decided that in so far as it was possible during the next twelve months I would devote the necessary time and energy to the interests of the affairs of the organization. Not so much that the president could contribute in such a large measure to its welfare. I realized, as we all did, that after all the affairs of the C.S.T.A. were to a large extent in the hands of the efficient and experienced General Secretary, the late Mr. Fred Grindley. It was, however, with the thought that the year of office would give one an opportunity of obtaining a wider knowledge of the work of the society and its field of service and what was of even greater importance, it would offer the very great privilege of meeting the members in the various locals from east to west. This opportunity for widening acquaintanceship and forming connections and friendships with the large body of men engaged in agricultural work in Canada, in all its various phases, is undoubtedly a privilege that means a great deal.

Shortly after taking over the Presidency in June 1929, I visited headquarters at Ottawa and spent two days with Mr. Grindley discussing in an intimate way the activities of the C.S.T.A. I shall always recall with much pleasure those two days. Mr. Grindley and I sat in the lounge room and talked over C.S.T.A. affairs in all its ramifications. Amongst other things we discussed the desirability of visiting within the next year as many of the local branches as possible. In November this proposed programme was initiated with a visit to Nova Scotia when we met the representation of the Maritime locals Following this we stopped over at Quebec City for a visit with the local there. Proceeding to Montreal, the Montreal and Macdonald College branches held a combined luncheon. On my return west I stopped at Winnipeg and addressed the Manitoba local.

Mr. Grindley and I had definitely planned to meet in Saskatchewan early in 1930 and visit the two local branches there, possibly hold one meeting in Alberta and from there go to British Columbia to join that local branch at its annual convention. Unfortunately, due to the untimely death of Mr. Grindley it was impossible to carry out the programme that had been arranged.

The affairs of the C.S.T.A. have been disturbed by the passing of Mr. Grindley and the necessary delay in the appointment of a successor. A tribute to his services to the organization and as a close personal friend to all the members has been expressed so fully and graciously by Dean Barton that I need add nothing further. There is, however, one feature of the events of the past few months of which I feel justified in speaking and that is the splendid spirit of loyalty and willingness to help displayed by the members

of the C.S.T.A. Times of sorrow and difficulty present opportunity for true friends to lend a helping hand and in this connection when the hand of one who for so long had guided the affairs of the Society was stayed, there were many loyal supporters who stepped into the breach and assumed the responsibility of carrying on. It is impossible to mention the names of all who have helped to bear the heavy load during the past few months. The list is too lengthy to give in full at this time. There are, however, two names that I wish to mention particularly as having rendered most valuable service and who did not spare themselves in order that the affairs of the society might be kept running smoothly. I refer to Miss Helen Henry, who for some years now has been in active service at headquarters, and Mr. L. H. Newman, Honorary Secretary. Miss Henry since her connection with the office in Ottawa has proven her loyalty and devotion to the society and especially during the past six months she has been a tower of strength. Mr. Newman, elected every year since the organization of the Society as Honorary Secretary, cheerfully assumed the duties of General Secretary at the time of the death of Mr. Grindley and since has worked late and early in the interests of the society. The result has been that the C.S.T.A. has continued to function in its usual efficient manner. May I be permitted on behalf of the society to express to both Miss Henry and Mr. Newman our most sincere thanks and to assure them that their sacrifices and efforts have been greatly appreciated. I should like also to make reference to the names of all those in Ottawa, and there were several, together with those further removed who served the society so well during the recent rather trying period.

The 1930 Convention completes ten years of history of the Canadian Society of Technical Agriculturists. Not a long period as agricultural development is usually measured, but of sufficient length that it is possible to determne with some degree of accuracy what it has accomplished for the profession which it represents and to what degree the members have appreciated its services. At this particular time one is inclined to look back at the past and review the work of the society. It has been a period of worthwhile accomplishments and has been marked by the realization of the hopes and vision of those who conceived the idea of the organization and of those who have since the convention held in Ottawa in 1920 given so freely of their time and energy. One could speak of the growth of the society from a relatively small membership to the point where today it is one of the strongest professional societies in Canada. One could mention the development that has taken place in the official magazine, *Scientific Agriculture*. It stands today as a scientific publication that has a wide circulation, one from which articles are abstracted in scientific journals in almost every country and in almost every language, and a magazine that occupies a prominent place in the field of scientific journalism. One could emphasize the most valuable type of work that has been accomplished by the different standing committees and through the medium of the local branches. The recognition that the organization has received from so many different sources could be pointed to as showing the important place it has attained in the agricultural life of Canada. It can be claimed that the society during the past ten years, has offered leadership, its members have rendered worth-

while service in many ways and its record of achievements has been one which has established this relatively young society on a solid basis.

It is true that when this society was first formed there was doubt in the minds of not a few as to whether or not there was justification for such an organization. Looking back now it can be seen how unfounded were such ideas and how wisely and well the foundation was laid. Through good judgment in adopting sane policies and an unselfish desire to serve in a broad rather than a personal way, the society has won the confidence of a large body of men, not alone those directly connected with agriculture, but many altogether outside of the profession. When one stops and considers the contribution the society has made to the general well-being of agriculture and the standing of the profession today as compared with ten years ago, then one begins to realize how much the C.S.T.A. has accomplished.

So much for the past. What about the future? What vision have we of what the next ten years' progress may mean? What fields of service are opening up wherein the society can function in the best interests of the profession of which we here form a part? These are the questions that concern us at this time. It is a forward rather than a backward look that we must take.

I believe there never was a time in the history of the agricultural development of Canada when there was greater need for leadership and wise counsel than the present. Those who have been in any way fairly closely associated with the profession within recent years have, no doubt, recognized the fact that agriculture appears to be entering a period of some considerable adjustment in its economic and social life.

Events of the past few years have indicated quite clearly that a change is taking place in the agricultural industry on the North American continent at least. As applied to many other industries this process of transition has already taken place. We have witnessed a definite change within the past ten years in production, marketing and distribution of innumerable products. The smaller stores have gradually given way to the large mercantile houses and the chain stores. Large scale production, in which greatest use is made of labour saving devices has already displaced many of the less important manufacturing enterprises. There has been much activity in the development of natural resources together with a rapid expansion of new and important industries. The result has been that business has become highly organized, competition has become keen and there has been a decided change in our entire industrial life. This development has all come within recent years and is so familiar to all that there is no need to enlarge upon it. Whether or not it has all been in the best interests of the industrial field might be open to argument. The point is that it has actually taken place.

It will be admitted with little questioning that while these changes have been in progress in other industries relatively little in the way of adjustment in agriculture has taken place. It is a fact that changes come more slowly in the field of agriculture. This does not necessarily imply that as a class those engaged in the business lack the keenness of mind or the initiative of individuals associated with other businesses. It may, on the other hand,

indicate that agriculture possesses more stabiliy, and a less complicated and intricate structure than some of the other industries. It was to be expected, however, that the changes which have already taken place in the industrial world would eventually find an application in agriculture. In order that any business may survive and compete with others it cannot long stay out of step, and while the reconstruction period in the case of agriculture may have been delayed, it is possible that the next few years may be a time of adjustment and the upsetting to some extent, of the older order of things and the introduction of new ideas. Having regard for all these facts, it is not surprising to learn that already serious discussions are taking place on such questions as production costs, the application of labour saving devices, better farm management methods, organizations for distributing and marketing, the possibility of larger scale production ,and all the innumerable factors that are now considered to have a direct relationship to the economic life of agriculture. In other words, the application to agriculture of those principles that have, in the minds of some at least, been an advantage in other fields. The adjusting periods in the life of any industry, just as it is in the case of a nation or of an individual, is a time that develops many new problems and that calls for a careful study of conditions, clear thinking and the application of sound policies. It is not suggested that the situation in agricultural industry is one that need cause alarm. There is, however, the concern that in the transitional period which appears to be at hand, there will be conflicting ideas which will tend to create a chaotic condition and may disturb, for the time being, the stability of the industry.

Already there is evidence of the fact that considerable difference of opinion prevail in regard to what is best for agriculture. It apparently seems to be considered the privilege of many altogether outside of the field to discuss the problems of agriculture in a dogmatic way and to offer unseasoned opinions.

The fact that this society includes in its membership men with scientific training, a wide experience as a result of an intimate relationship with the practical problems and a sincere and unselfish desire to forward the general well-being of the industry is surely justification for the belief that the men connected with it might well offer just the type of leadership that may be valuable during the next few years. And so, on the strength of this, it is reasonable to conceive the idea that the next ten years may offer a new and wider field for service to the men engaged in professional agriculture.

It is admitted, I believe, that the men associated with professional agriculture have had difficulties to face and prejudices to break down that have not been experienced in possibly any other profession. It is recognized that the organizations that have been built up and the services offered in promoting the interests of agriculture have possibly no parallel in other industries. No criticism is offered for the contributions that have been made in this regard. It is admitted that the importance of the industry in relation to the general welfare of the country is sufficiently close to warrant all the assistance that has been given. The fact remains, however, that out of this has arisen a too general lack of appreciation and an attitude of in-

difference on the part of a considerable number of men engaged in the purely practical phases of agriculture. Just in this connection, I should like to read a statement made recently by Max McConn, Dean of Lehigh University, and the author of *College or Kindergarten*. He was discussing the attitude of some towards what is known as specialists and here is what he says:

> "We live in a period when viewing with alarm is a favourable indoor sport, and when one of the principal objects of such viewing, among magazine writers at least, is the Specialist—meaning, apparently, any person who has attained to any reasonable mastery in science, literature, philosophy, or any other branch of human learning.
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> We are all familiar with the horrid aspect of this creature as frequently depicted for us in various journals. He has usually, it would appear, been caught young and strictly immured within the close and barren precincts of graduate school, where all his natural expansive and free-roving mental processes have been cribbed, cabined and confined in the straightjacket devised for the manufacture of Ph.D's. When eventually turned loose, he regularly joins a university faculty or else proceeds into some minute specialty within one of the learned professions. And thus the tree grows as the twig was bent. He goes on "learning more and more about less and less". It is understood that he is invariably dry, dessicated, and above all narrow—that he takes no interest, and is capable of taking no interest in anything outside his own ever more restricted field—that in short he becomes a human monograph, a learned treatise, on two dwindling shanks.
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> And so, we are told, we must envisage a time coming when none of us, or at least none who have had university training, will be able to understand any of the rest, when each will stand solitary, babbling unintelligently of his own specialty, with no one to correlate the results to any useful human end or to interpret them in the light of any philosophic values".

This very well depicts the reaction of a number of people at one time towards agricultural experts, so called. Dr. McConn goes on to say:

> "This picture is indeed somewhat terrifying, but the trouble with it is that when we turn to the actual world and look around among our more or less learned friends, scientists, mathematicians, engineers, physicians and economists, it is extremely difficult to find a living specimen who will really check against the diagram".

This last statement, I believe, expresses the attitude of more and more people towards the whole question of agricultural education. There is a greater appreciation today of the important place men with a scientific training have in the field of agriculture than was the case some years ago. It is a fact that people are turning in increasing numbers to those men for information and direction. Much of the misunderstanding and misconception that at one time clouded the whole horizon of professional learning as applied to agriculture has been cleared away by the rays of intellectual light that have been shining forth for the past number of years as the result of the distinct service

that has been rendered by those connected with professional agriculture. There never was a time in the history of agricultural development when the influence and standing of professional men associated with it have rated higher. And so as we stand at this time, attempting to analyse what the future development of the C.S.T.A. might be, it seems to me that the words of Carlyle in which he so well describes the secret of genius would apply to this organization at this time:

> "To carry the spirit of childhood into old age, as with children with little interest in the past but boundless curiosity about the future, with little care about what tomorrow may bring forth so long as it is different from today, with no petty regard for what we hay have said or done in the past; flexible, growing, easily bent, but never broken, hoping, dreaming, trying, ready for any change."

Professional agriculture in Canada has been enriched during the past ten years through the efforts of the C.S.T.A. It is not always easy to measure in definite terms the results achieved by such an organization. There is, however, every reason to believe that agricultural service is much more appreciated today than it ever was. There is no doubt but that the men engaged in this field are more highly trained and better qualified than was the case a decade ago. Agricultural research has made much progress and the courses of study offered at our educational institutions have greatly improved. It is not claimed that the C.S.T.A. has been responsible for all this. It has, however, made a significant contribution. In fact, it has been said, with much foundation, that the inspiration and ground work for much that has been accomplished has come indirectly through the efforts of this society.

REPORT OF THE ACTING GENERAL SECRETARY

PRESENTED AT THE TENTH ANNUAL CONVENTION, C.S.T.A., WOLFVILLE, N.S., JUNE 24, 1930

L. H. NEWMAN

In presenting the Tenth Annual Report of the Secretary of your Society, I need hardly say that it is a matter of profound regret that this report has to be submitted by anyone other than by him who for practically a decade played so prominent a part in the affairs of this organization. Dean Barton has already expressed the thoughts which I am sure are shared by the whole membership body regarding the stupendous loss sustained by our Society through the death of Fred Grindley. It only remains for me to voice the hope, already expressed elsewhere, that we may be able to continue the work in the foundation of which he played so large a part.

In many respects, I believe, the present report may be considered more encouraging than any presented thus far, showing as it does a substantial increase in our membership, an enlargement and improvement in our Journal and a financial condition more stable than any previously reported. The satisfactory improvement in the condition of the Society may be regarded as the natural outcome of the organizing ability and industry of our late

General Secretary rather than to anything which may have taken place since his death. I propose in this report to adopt the general course followed in previous reports and present the details of our activities during the past twelve months.

Membership

On May 31, 1929, the total membership of the Society, reported at the Winnipeg Convention, was 1084, made up of 1041 regular members, 7 life members and 36 student members. Since that time it has been necessary to remove the names of 32 regular members for non-payment of fees or because of death or resignations. During the same period 106 regular members have been admitted .

I regret to report the loss of three members through death: Mr. F. H. Grindley, our General Secretary and Managing Editor, on February 14th, 1930, Dr. J. W. Robertson, on March 19th, 1930, and Dean W. J. Rutherford, on June 1st, 1930.

The present total number of regular members is, therefore, 1,124. The number of student members this year is 39 as compared with 36 last year. No life memberships have been taken during the year and the total number of these is six as compared with seven last year. Mr. Grindley was a life member.

The total membership on May 31, 1930, was 1163 as compared with 1,084 on the same date in 1929. Ninety-one per cent of the members were fully paid up on May 31, 1930.

The foregoing information is condensed in the following:

1929 Membership:		
Life members	7	
Regular members	1,041	
Student members	36	1,084
Taken off:		
Student members	34	
Resignations	29	
Deaths	3	
Total loss		66
Balance		1,018
New Members:		
Regular members	106	
Student members	39	145
Total present membership		1,163

An increase of 79 members during the year as against a net increase of 61 in 1929, is very encouraging, especially when we remember that the Society is now entering its eleventh year, and is almost entirely dependent upon recent graduates for membership increase. A fairly extensive and carefully prepared membership campaign was conducted in the fall of 1929.

There have been noticeable increases in membership in British Columbia, North Saskatchewan, South Saskatchewan, Alberta, Manitoba and Quebec City. The present distribution of membership is as follows:

Alberta	122
British Columbia	111
Manitoba	89
New Brunswick	39
Nova Scotia	37
Eastern Ontario	118
Northwestern Ontario	3
Western Ontario	167
Niagara Peninsula	30
Prince Edward Island	9
Macdonald College	78
Montreal	73
Quebec City	72
Ste. Anne de la Pocatière	38
Northern Quebec and Ontario	20
North Saskatchewan	62
South Saskatchewan	51
British and Foreign	12
United States	32
	1,163

List of Members

The official list of members was compiled and published in May 1930, and a copy sent to each member. This publication is considered a useful reference and makes a very effective medium in soliciting advertising from commercial firms which might be disposed to take space in *Scientific Agriculture*. It is hoped that the annual publication of this list may be continued.

Scientific Agriculture

The Journal has continued to receive financial assistance from several sources which are named on the front cover of each issue and the maintenance of the journal in its present form depends upon these grants. A large part of the advertising revenue is applied to the expense of publication.

During the past year the number of manuscripts received has been considerably in excess of that receved last year and it is becoming increasingly difficult to guarantee publication as promptly as has been the case in the past.

The wide range of subjects covered by the manuscripts received can be ascertained from the following classification made of articles published during the past year:

Animal Husbandry	8
Plant Pathology	4
Plant Breeding and Genetics	14
Plant Ecology	1
Weeds	3
Field Technique	2
Plant Physiology	3
Professional articles of general interest	2
Agricultural Economics	4
Entomology	3
Baking Technique	1
Feeds and Feeding	2
Dairying	5
Horticulture	4
Animal Genetics	1
Agricultural Education	1
Poultry Husbandry	2
Animal Nutrition	1
Milling	1
Soils	1
Fertilizers	2
Field Crops	2
Marketing	1

The "Notes and News" section of the magazine has occupied slightly more space than in former years, covering an average of four pages per issue, which is a step towards carrying out of the recommendation made last year at Winnipeg by the Committee on Publications that a minimum of four pages per issue be maintained.

Subscriptions have increased markedly in the last year, and exchanges are developing, particularly in foreign countries. Exchanges are now in force with scientific journals from almost every country and in almost every language.

The T. Eaton Company Scholarships

The five T. Eaton Company Scholarships of $600. each awarded at the last convention were all taken up with the exception of one. Mr. R. H. Bedford found it necessary to withdraw his application at a date too late to allow the scholarship to be given to an alternative candidate. The Board of Directors has since set September 1st as the date upon which successful candidates must advise the Society of their decision as to the taking up of scholarships in order that alternative candidates might be given some consideration. The donors consented to this scholarship being held over until this year and the amount used, along with one of this year's scholarships, to establish a $1,200. scholarship tenable in Great Britain.

Three of the four successful 1929 candidates who took up the scholarships carried out their graduate work at the University of Toronto and one at the University of Alberta.

The scholarships have been donated to the Society again this year and there are fifteen candidates for them. A committee has been appointed by the Board of Directors to select the five successful candidates, and the decision of this committee will be announced at the present convention.

Survey of Graduate Facilities

As announced in the report of the General Secretary last year, a survey of graduate facilities was undertaken by Dr. Robert Newton and was completed at the time of the last convention. This survey was financed by the International Education Board of New York City. Dr. Newton's report was printed last fall and a copy was sent to each member of the society and to each member of the graduating classes in agriculture at the various colleges and universities. It is planned to send a copy of this report to these classes each year.

Chilean Nitrate Grant

A grant of $600. from the Chilean Nitrate Committee to assist in the maintenance of clerical assistance in the central office was received during the past year.

Employment Bureau

At a meeting of the Board of Directors held at Winnipeg on June 15, 1929, the following Employment Bureau Committee was appointed.

E. S. Archibald, Chairman.
H. G. Crawford,
G. LeLacheur,
A. T. Charron,
Fred. Grindley.

Subsequent meetings of this committee were held, and the Executive Council, at a meeting in Toronto on November 23, 1929, agreed that this Bureau should function to the extent of advertising in *Scientific Agriculture* vacancies in the professional field, and that Federal and provincial governments, agricultural colleges, commercial firms, etc., be notified that such announcements will be carried in the journal without charge. Plans have been formulated for the publication of a suitable booklet to be sent to the above mentioned institutions and organizations, and a very extensive mailing list is being compiled for use in connection with the distribution of this booklet when printed. The pressure of work in the central office has prevented this work from going forward as rapidly as was hoped.

A statement outlining the plan was published in *Scientific Agriculture* and since that time advertisements have appeared in the journal.

Text Book Club

The sale of agricultural books to members, through the central office has continued throughout the year and this service has been very well patronized and seems much appreciated by members. Practically all pub-

lishers of agricultural books are now giving the Society the benefit of a trade discount, which is turned over to members who order books through the Society.

Local Branches

Special mention should be made of the various local branches which, in most cases, have been much more active than usual. Since the locals constitute so vital a part of the Society as a whole and since the life and usefulness of the latter depend so largely upon the activities of the former, it would appear to the Acting General Secretary at least, that every assistance and encouragement possible should be given these bodies. To this end it might be advisable to suggest that the incoming executive provide a larger place on the next programme for reports by each local and for a proper discussion of same. No new branches have been organized during the year, and the total number remains at seventeen.

Travelling

During the first six months of the year the General Secretary attended meetings of the following branches: Western Ontario, Niagara Peninsula, Eastern Ontario, Macdonald College, Montreal, Quebec City and a joint meeting of the three Maritime locals.

The amount of travelling in connection with the soliciting of advertisements has been necessarily much less than usual and the travelling expenses are approximately $200. below last year. The railway companies have unofficially accorded the same courtesies as in previous years, thereby keeping our travelling expenses at a minimum.

Finances

The financial statement for the past year is in your hands and should be carefully studied. The most important items will now be referred to:

The chief feature of this report is that the cash balance of $2,870.92 with which we closed our books a year ago has increased to $5,618.82 and the actual credit balance of $3,486.42 on May 31, 1929 has increased to $6,586.02. Thus there would appear to be an operating surplus of $3,099.60. From this amount the unexpended balance of the T. Eaton Company Scholarship fund, namely $600.00, should be deducted, leaving a net operating surplus for the year of $2,499.60. It should be borne in mind however that of this amount $1,350.00 can be accounted for by the fact that the salary of the General Secretary was only paid for nine months of the year at the rate of $3000.00 per year instead of $3600.00 as was the case last year. The travelling expenses of the General Secretary are also approximately $200.00 below last year. Therefore, without taking into account these items which would not be revenue in a normal year, there was a net operating surplus of $949.60 for the year as compared with $702.38 last year in spite of the heavy increase in operating expenses.

On the whole the report is quite satisfactory and gives reasonable assurance of financial stability, of course, there is naturally no stability to such sources of revenue as advertising and grants, which constitute about fifty per cent of our normal annual income. Continued effort is necessary

to keep them up to the required amount, and any serious industrial depression, or falling off in institutional support, would have a serious effect upon our finances.

Headquarters

In the General Secretary's report last year an announcement was made giving full particulars regarding the establishment of adequate headquarters for the Society at Ottawa, which were opened on May 1, 1929. These rooms (lounge room and board room) are available for the use of members, affiliated societies and in fact of all those engaged in any branch of agricultural science in Canada. During the year the registration book kept for visitors contains over 700 names of those who have used these rooms.

No reference to the expenses of these headquarters appears in the financial statement. A separate rental and equipment account was opened covering these operations, and two representatives of the contributing firms were named to act as advisors to the Society in the administration of this account.

Tenth Annual Convention

Plans for this convention, which is the tenth anniversary of the Society, were initiated at a non-official meeting at which the retiring President and late General Secretary were present, held at Amherst, N.S., on November 14, 1929. Practically all of the organization work has been done by the Maritime Organization Committee and the Convention Committees named in the convention programme.

Grateful acknowledgement is due Acadia University, the Departments of Agriculture in the three Maritime provinces, the Dominion Experimental Station at Fredericton, N.B., the Dominion Experimental Station at Kentville, N.S., the Dominion Experimental Farm at Nappan, N.S., the Prince Edward Island Motor League, the Charlottetown Board of Trade, P.E.I., the Dominion Experimental Station, Charlottetown, P.E.I., and the three Maritime local branches of the C.S.T.A. for complimentary luncheons, banquets and other forms of hospitality. Special mention also should be made at this point of the assistance given by the Dominion Department of Agriculture in making possible the series of lectures included in the programme.

The following official delegates have been appointed by the various local branches.

Manitoba: F. W. Brodrick, W. F. Hanna, T. J. Harrison, W. R. Leslie, W. C. McKillican.
New Brunswick: C. F. Bailey, J. W. Graham.
Nova Scotia: W. W. Baird, C. E. Boulden.
Eastern Ontario: E. S. Archibald, J. F. Booth, H. G. Crawford, F. Larose, W. T. Macoun, J. C. Moynan.
Western Ontario: J. A. Carroll, R. S. Duncan, R. Harcourt, J. K. King, A. W. Mason, A. H. McLennan, W. J. Squirrell, J. C. Steckley, W. H. J. Tisdale, S. E. Todd.
Northern Quebec and Ontario: L. J. Begin.
Niagara Peninsula: J. B. Fairbairn, E. K. Hampson.

Prince Edward Island: J. A. Clark.
Montreal: P. N. April, H. E. Lefèvre, L. Therrien, P. H. Vezina.
Macdonald: H. Barton, J. G. Coulson, L. H. Hamilton, G. R. Lane.
Quebec: Leo Brown, Henri Lavoie, F. N. Savoie.
North Saskatchewan: Manley Champlin, J. B. Harrington, A. M. Shaw.
South Saskatchewan: F. H. Auld, J. G. Robertson, S. H. Vigor.
Ste. Anne de la Pocatière: B. Baribeau, A. Godbout.
Alberta: Not yet appointed.
British Columbia: A. F. Barss, F. M. Clement, W. M. Fleming, L. S. Klinck, G. G. Moe, J. B. Munro.

New Officers

Ballots for the annual elections were mailed to all members on April 10th and opened at Ottawa on April 30th. 776 members voted. The following official results were announced through the Canadian Press on that date and published in the May issue of *Scientific Agriculture*.

President: W. T. Macoun.
Vice-Presidents: H. S. Arkell, Georges Bouchard (re-elected).
Honorary Secretary: L. H. Newman (re-elected by acclamation).

Meetings of the Board of Directors

Meetings of the Board of Directors were held at Winnipeg, Man., on June 15th, 1929, at Toronto on November 23, 1929, at Ottawa on March 12, 1930, and at Wolfville, N.S., on June 24, 1930.

In closing I would like to extend my personal acknowledgement and thanks to the members of the Board of Directors, the various committees and the local branch secretaries for the very excellent support and wise counsel which they have given me during the four months I have endeavoured to carry on. I would also like to express my personal thanks to our French Secretary and Editor, Mr. H. E. Lefèvre, for his coöperation and help throughout the year but more particularly since the death of our General Secretary.

I should like especially, however, to acknowledge my personal indebtedness as well as that of the Society as a whole to Miss Helen Henry who so unselfishly shouldered the extra load and responsibility resulting from Mr. Grindley's death. Personally, I hesitate to think of the straights we would have been in had we had a less capable and reliable person in her position during this trying time.

I know of nothing further that need be reported at this time. Your Society is in good condition financially while recognition is being received from an increasing number of sources.

The tenth year of our operations has now closed and I think we may look back upon this first decade with just pride and see a steady growth, the consolidation of a large membership body, the establishment of a creditable journal and a long list of worthy accomplishments. In the words with which our late General Secretary closed his last report, "let us hope that the future of our Society will be equally encouraging and stimulating."

REPORT OF C.S.T.A. COMMITTEE ON AGRICULTURAL POLICIES

E. A. Howes, *Chairman*

In presenting this fourth report of your standing Committee on Agricultural Policies, a word or two of explanation and comment is necessary.

Last year the report adopted at Winnipeg rather pointed to the necessity for widening the scope of our service and recommendation—widening the scope to include intra-provincial activities, to include also other activities that might be described as private, although this was not specified in detail. This year it was thought we might take up the problem which has been described as intra-provincial relationships—relationships among institutions operating in a province.

Early in the year your Chairman sent a letter to each member of this Committee and also to the president of each local. The response was somewhat spotted, resulting in the receipt of four or five carefully prepared statements and several others not so carefully prepared. However, the material in the aggregate was particularly helpful and the trend of this report has been shaped altogether with the purpose of putting some of the most striking opinions before the annual convention.

1. There seems to be an almost unanimous opinion on the part of the correspondents that there is, after all, a certain amount of overlapping of activities, but that, in the main, these are not undesirable and that the problem does not lie so much in the elimination of activities as in the coördination of information given to the public. For this purpose, and again this opinion seems practically unanimous, the formation of joint committees such as seed boards, livestock boards, and such, many of which are now in active operation, have been pointed out as a means by which the aforesaid coördination may be secured. Following are some comments in connection with the statement just made:

(a) "The various agencies do not overlap appreciably in the teaching of the fundamentals of agriculture, this being left to the schools and the provincial university. There is overlapping with respect to the dissemination of information both verbal and written, for example, crop cultural and varietal pamphlets, bulletins and reports issued by the Federal and provincial institutions, the T. Eaton Co., and the Wheat Pool. As to friction or irritation resulting from this overlapping, I know of no cases and doubt if there is an appreciable amount. In my opinion the existing overlapping concerns, in most cases, important information that will bear much repeating, such as recommendations on the best varieties to use or on methods of controlling weeds.

The danger that does exist is not that of overlapping so much as the issuance of conflicting statements from different sources regarding the same problem. The formation of special advisory committees in Saskatchewan representing each important phase of agricultural endeavour should meet the situation.

In my opinion frequent conferences of small groups on closely related problems, joint enterprises both investigational and informational, a spirit of service and a frank expression of opinion will be effective in controlling overlapping and preventing irritation or friction."

(b) The following statement from Dr. Archibald probably crystallizes the whole symposium of opinions:

"*Overlapping Policies*—I think I know what is meant by this. I am in the very fortunate position of having a very large number of friends and acquaintances on the staffs of each of the provincial departments and universities and I have a fairly intimate knowledge of much of the work that is being done by these institutions.

Because the Experimental Farms system was first in the field in practically all lines of endeavour, this does not, in my opinion, eliminate some of the criticism as to some of the present slight overlappings. I believe, however, that insofar as all investigational work is concerned the overlappings are negligible and that the work being done by these and other institutions is but necessary replication rather than duplication, and if the men of the committees of the C.S.T.A. or otherwise were but working in the fullest coöperation there would be no criticism as to such work.

Provincial Committees—I think that the formation of provincial committees gradually and according to the needs is one of the finest ways of bringing workers together. A meeting each summer to see the work in progress at the provincial and Federal institutions and a meeting each winter to sit around a table and thresh over the year's data acquired not only keeps these men on their mettle and gives them information common to all but at the same time develops mutual confidence which is of the greatest possible value in such work.

I think it would be unwise to create a fleet of committees, but as problems arise which would justify such, in my opinion, this has already proven a very wise step in advance."

2. There is a feeling that the formation of provincial committees for each specific problem is not enough. In the Province of Saskatchewan the workers in the different fields of agricultural endeavour have come together and organized a provincial committee called the Saskatchewan United Agricultural Committee. This committee was organized for the broad purpose of the betterment of agriculture but this constitution states at the outset that its purpose is "to effect an organization within the Province of Saskatchewan which will embrace the field of agriculture and serve to coördnate the activities of as many organizations as possible."

The following extract is taken from the constitution of the Committee and is self-explanatory:

"*Name*: The name of the organization shall be the Saskatchewan United Agricultural Committee.

Aims: The aims of the Committee shall be to inculcate in the minds of those engaged in the industry a greater desire for improvement in the art of farming, to work always for the application of science to agriculture,

to coöperate fully with all established bodies in conformity with the objects of the Committee, to combine ideals with practicability to the utmost extent in all respects and to secure for the industry a progressive and profitable development, to the end that farm life in Saskatchewan may be made more satisfactory and inviting.

Objects: The objects of the Committee shall be to secure the adoption of more efficient and profitable farm practice generally, to promote the conservation of soil fertility in Saskatchewan, to bring about the inauguration of policies looking toward the development of a permanent system of agriculture, to encourage the greater beautification of farm homes and their surroundings and to coördinate the activities of all useful bodies in the agricultural industry of the Province, without in any way interfering with the special functions of any.

Membership: The membership of the Committee shall consist of one representative from each of the following:

The Provincial Department of Agriculture.
The University of Saskatchewan.
Extension Department, The College of Agriculture.
The Dominion Experimental Farm, Indian Head.
The Dominion Experimental Station, Swift Current.
The Dominion Experimental Station, Scott.
The Dominion Experimental Station, Rosthern.
The United Farmers of Canada (Saskatchewan Section).
Saskatchewan Coöperative Wheat Producers Limited.
The Saskatchewan Live Stock Coöperative Marketing Association.
Saskatchewan Registered Seed Growers Limited.

Saskatchewan Coöperative Poultry Producers Limited, and from such other organizations, provincial in character and whose activities are entirely confined to agriculture, as shall from time to time be added on the unanimous vote of the Committee."

3. Heretofore we have been discussing policies as implemented by the various departments of agriculture—Federal and provincial. Some of our correspondents have pointed out that while teaching and research have been almost entirely handled by government agencies, the other great activity, which in our reports we have called field work, as being rather broader than extension, have been invaded by many institutions which we may describe as private. One writer points out that the following types of institutions are active in agricultural field work:

(a) Coöperative organizations.
(b) The press.
(c) Banks—through local branches of large organizations.
(d) Technical societies.
(e) Commercial companies—seed firms, machinery firms, merchandise firms.
(f) The railways.

(g) Fertilizer manufacturers.
(h) Malting companies.

This may not be a complete list, but it is fairly comprehensive.

It has been suggested from many sources that the C.S.T.A. might do something to coördinate the activities of these institutions. It might be well at the present meeting to give some attention to this problem and so, to lead the discussion, the following suggestions are offered:

(a) Where business companies of different types are interesting themselves, sometimes at considerable expense, to disseminate technical information in agriculture, it would be well for our Society, either through its local or through provincial committees, where such exist, to establish a liaison with whatever private institutions may be desirous of public agricultural service and offer such advice as may seem logical and necessary. If the advice be not taken there is not much can be done about the matter, but in the most cases we believe such advice would be welcome.

The committee, or committees, in each province in giving advice would have to study carefully such points as the motive that prompted the proposed service, because manifestly the degree to which the altrustic might actuate proffered service would vary considerably. It is patent that some of it could not be considered as much more than a rather good type of advertising, some of it would be a sort of logical outcome of other activities of the institutions concerned; while, in a few cases, the offer of such service would be to a very large extent disinterested.

(b) There is a specific problem in connection with the press. The press has for many years been a great factor in carrying agricultural information from the technical agriculturists to the farmer and has also been of great service in making vocal the many needs of the farmer, and incidentally also of the technical agriculturist as well. Not only do we recognize this great service but we are deeply grateful for it. Because of this, one approaches, with diffidence, any attempt at criticism however constructive. Nevertheless, the Committee is of the opinion that the better newspapers and periodicals would welcome the offer of advice from committees representative of the large teaching and research institutions. Some system could surely be established whereby the provincial committee just mentioned, or the nearest local member of that committee, might advise the press as to the proper authority to pronounce upon statements and recommendations that, in the ultimate analysis, must have a very imporant influence on agriculture in general.

The Chairman would like to cite, as an outstanding example of this, the great number of articles that have appeared within the past year in regard to marketing and in regard to farm mechanization. Rightly or wrongly, many of us in the West feel that a large number of these articles are misleading and that some have had a very harmful influence on agricultural practices in a new country, where such are easily upset. With two or three exceptions it would appear that the authors of these articles are comparatively unknown and not possessed of any brief to speak on such serious

problems through the press. This sort of thing is going on despite the fact that the report this Committee adopted last year, made a special plea for an open season on hack writers. We are sure that many of the publications that we can call to mind would be glad to benefit by the active interest and advice of a member, or members, of a provincial committee made up of responsible technical agriculturists.

4. Two locals have forwarded rather emphatic recommendations as to the next step in connection with agricultural policies. They are of the opinion that for such important work, requiring so much detailed investigation, a commissioner, or commissioners, should be appointed by the Society to study the whole field and make recommendations. A suggestion is made as to how this might be financed.

The following extracts from the two communications are submitted for the consideration of the convention:

(a) "Thinking about the matter very seriously and realizing how disappointed you will be at my apparent lack of coöperation, I can see no method of getting at the situation in Ontario other than by securing an investigator comparable to Dr. Newton in his study in respect to post graduate study opportunities in Canada. In this way the various officers, the district representatives, etc., could be interviewed, the information correlated and a broad concept of the situation secured."

(b) "We would suggest that arrangements be made so that a thorough survey be conducted in each province and the whole incorporated into one report outlining an agricultural policy that would cover the whole Dominion. We are of the opinion that there is more overlooking than overlappnig at present and not enough coördination right down the line to the man on the land. The cost of such a survey as we suggest could either be defrayed by a special contribution for the purpose either from the Federal and provincial governments, or as a donation from some big industrial concern which is anxious to perform some special service to agriculture. The survey could be carried out by the C.S.T.A. for the industrial concern. A survey of this kind would be authoritative and more likely to be acted upon than a spasmodic attempt to collect a lot of information in odd moments as would have to be the case if the matter is carried out as suggested at present."

5. This Committee, at last year's convention, made some specific recommendations as to relationships between provincial and Dominion organizations. We are of the opinion that publishing this in the *Scientific Agriculture* was not enough, considering the importance of the report, which really crystallized the study of three years. We would suggest that this year's report might get published in leaflet form and sent, with a covering explanation, to every member of parliament and to every member of legislature, as a specific indication that our Society has been seriously studying the problem that has so often been referred to by individual members on the floor of the House. In this connection there can be no harm in saying that the results accruing from much of the work done by this Committee will not be made manifest in any spectacular recognition. As has often been pointed out, the greatest good will probably come from the active awakening

of our minds to the necessity for all technical agriculturists working together, to the end that agriculture shall operate upon, and be raised to the plane that its importance deserves.

SUMMARY

(1) Overlapping in agricultural field work can not often be described as undesirable. There is a need, however, for some coördinating factor in the matter of information offered to the public.

(2) Saskatchewan has established a United Agricultural Committee. We should seriously study the experiment going on in that Province.

(3) There is need for some attempt at guiding and coördinating the field work activities of institutions that may be described as private.

(4) Two locals recommend a definite official survey of the whole field of agricultural policies, a survey similar to that made of the field of graduate work.

(5) Special effort should be made to have our findings brought to the attention of Members of Parliament and Members of Legislature, in order that they may realize that our Society is making an earnest effort to analyze and solve a problem that has at times received a publicity not altogether relished by technical agriculturists.

REPORT OF C.S.T.A. COMMITTEE ON PROGRESS

D. H. GALBRAITH, *Chairman*

The past year has been one of unusual activity and development in the Canadian Society of Technical Agriculturists. Whatever yardstick may be used as a measure will indicate progress. The ready response to a circular letter from the Committee on Progress was most gratifying and goes to show that the local units of this organization are alive and doing their part. The one great handicap to many locals is the great area over which the membership is spread, making it impossible to hold regular meetings that will be well attended. In some provinces practically all meetings are held during fairs or conventions when there is likely to be a gathering of the clan.

The membership again shows a good healthy increase as has been the case every year since the society was organized. One local reports that every eligible person is now a member. Other locals are not far from this same objective. The enrolment of so many leaders in our agricultural institutions and agricultural departments has enabled our society to bring about a wonderful degree of coöperation and to eliminate the overlapping of activities. This is no doubt the society's greatest contribution to the advancement of Canadian agriculture.

Scientific Agriculture, the official organ of this society, has reached a new level as a scientific magazine. It is now worthy of a place in every library as a reference book on things agricultural and is an achievement of which the members are justly proud. What great strides of progress this official organ has made since the early days of this society when the opin-

ion was so often voiced that *Scientific Agriculture* should be made more fraternal.

To increase the membership or expand *Scientific Agriculture* can no longer be depended upon to keep up the interest in this society. New activities must be taken on. Some locals have arranged social and fraternal gatherings with good success. Many locals have divided into groups and held sectional meetings. It may be of interest to note that one local after organizing several groups has decided to carry on this coming year with only two groups, Animal Science Group and Plant Science Group. Each province appears to have its own problems and each local must be depended on to determine the best method of maintaining a live interest in this society.

Agriculture is passing through a period of severe depression. This is reflected in the general trade of the country and appears to be more fully realized by commercial organizations than by farmers themselves. Any person with a cure for the present ills is welcomed as a speaker or writer. Our membership realizes only too well the great damage that can be done, by placing unseasoned information in the hands of powerful organizations who at once attempt to have the idea put into practice. While this condition exists it is unfortunate that so many of our members who could deliver the best information available are prevented from doing so by virtue of the positions which they hold. It has been suggested to the Progress Committee that this annual convention might well formulate ways and means by which this Society can give more direct leadership to the actual producers.

In conclusion we wish to thank the locals for the outline of their year's work and express the hope that the coming year will record even greater progress than the past.

REPORT OF C.S.T.A. COMMITTEE ON ECONOMICS AND MARKETING

J. E. Lattimer, *Chairman*

Pursuant to the work already accomplished by previous committees the work undertaken this season has been the consideration of the necessity for, and the best method of, providing for the strengthening of the work in economics in faculties of agriculture.

The committee for this year consists of J. E. Lattimer, (Chairman), H. S. Arkell, J. A. Carroll, F. M. Clement and H. S. Fry. A convenient clause empowered this committee to add to its number. Consequently there was no hesitation in calling upon various members of the C.S.T.A. and others for information, suggestions and assistance. The response to this appeal has been indeed gratifying. It is therefore a pleasure, in presenting the report of your committee, to emphasize the coöperation and assistance received from:

1. The official members of the committee.
2. The members of the Canadian Society of Agricultural Economics.
3. Specialists in other lines of effort interested in strengthening the work in economics.

4. Graduates in agriculture who have entered various business fields.
5. Administrative officers of faculties of agriculture who have reported on the demand for work in economics at various institutions.

Present Conditions

Judged by results the present conditions in faculties of agriculture and agricultural colleges are not reassuring. With other faculties, in some cases at least, struggling to evolve a suitable plan to eliminate a proportion of student applicants, faculties of agriculture experience some difficulty in securing students. It is frequently suggested that the reason for this condition is on account of the comparative lack of prosperity in the farming industry. It is respectfully suggested that another reason may be that faculties of agriculture at present are in many cases failing to supply the type of training now in demand. Without subscribing to the idea that students are infallible in the knowledge of their own requirements it may be conceded that some recognition may be given to the demand of the times.

Whether the lack of interest in the curricula of faculties of agriculture be attributable to failure to offer work in demand or to the fact that the industry does not compare favourably with others in prosperity, or both, the need for strengthening the work in economics as the logical treatment of the situation will be apparent.

The present report does not demand, nor will time permit stressing in detail, the necessity for and advantages possible from the expansion of work in economics. It is essential, however, to devote a few sentences to the present condition.

The post war decade has accomplished more in banishing from the world the fear of famine than any other equal period of time. While this has been the general result those engaged in the business of farming have not shared in the general prosperity prevailing. Potential productivity of farm products is so great that the great struggle is in the market place. World competition dictates at present the reorganization of both marketing and production if world trade is to be retained. This reorganization requires an investment in farming unthought of in the more self-sufficing stage of the industry. The business of farming must be organized in such a way that some profit is possible in order that it may without hardship bear the increasing burden of taxation. With these problems before us can we afford to allow students in other faculties a monopoly of the study of such subjects as money and banking, international trade and public finance? These subjects are fundamental for leaders in agriculture where farm products form such an important item in international trade, the capital necessary to operate a farm is increasing so rapidly and the provision of funds for elementary education in rural districts is such a burden on the farming industry.

Possibilities of this line of effort coupled with the fact that in only one faculty of agriculture in Canada has economics been given the standing of an option would appear to justify the investigation carried on by your committee.

Information Obtained

Recognizing the tardiness with which Canada has entered upon this field of effort, much of the information obtained was of necessity sought elsewhere. Reports from a number of the larger universities in the United States as well as some of the younger institutions were secured. In these institutions economics has had during the past decade an equal standing with other subjects in faculties of agriculture, and report what would appear to be significant for our purpose that during this time an increasing proportion of students select this as their special field of study. The following tabulation is of interest:

Wisconsin Faculty of Agriculture

	Percentage undergraduates majoring in economics
1921	4.6
1927	9.8
1928	10.7
1929	7.7
1930	10.9

Graduate training in economics includes many who have specialized in other lines in undergraduate work.

Cornell Faculty of Agriculture

Cornell reports the percentage of teaching in agricultural economics as compared with that in what are termed the production courses, including animal husbandry, agronomy and horticulture—

	Agricultural Economics	Production Courses
1910-11	9.9	38.7
1915-16	5.7	29.1
1920-21	8.8	27.7
1927-28	11.6	15.1

In 1910 some courses in economics were compulsory, later all were elective. In addition to this, large increases are reported in rural sociology and education which are not included here. This and the increase in science accounts for the smaller proportion of time allowed during recent years for the subjects mentioned.

Minnesota

Eighteen per cent of the "weighted student hours" taught in the faculty of agriculture were in the department of agricultural economics.

Ohio

At the present time about ten per cent of the students enrolled in the faculty of agriculture major in agricultural economics. The proportion is increasing at about the rate of two per cent per year.

Oklahoma

Agricultural economics, besides being placed on an equality with other fields of study—in which as many students major as in any other line—

enjoys the distinction of being the only department offering a special course for the full four years, entitled Agricultural Administration.

Kansas

A major in agricultural economics has been offered since 1919. Recently a curriculum in agricultural administration has been established. This now includes about forty per cent of the sophomores, juniors and seniors in the faculty of that institution.

Texas

During 1925 and 1926 more students were enrolled in agricultural economics than in all of the technical courses combined. At present the enrolment is considerably less than that of the technical division. The decline of the past three years seems to be due to the fact that agricultural conditions have improved with increased interest in what are termed the technical courses.

If this contention is correct and the study of economics is only necessary when the industry is lacking in prosperity we might hope that this subject never becomes very popular locally. This is the only institution reporting a decrease in interest in this line of work and recent changes in the personnel may have had some influence.

Manitoba

A major in agricultural economics has been established for some time. Three years since a revision allowed options in the last two years when an agricultural business option was provided. The proportion of students taking this option to the total at present is:

Seniors	33.3 per cent
Juniors	37.5 per cent

Specialization in economics is frequently pursued in graduate training. In this connection it may be interesting to note how Canada compares with some other countries in this line. The record as published in the Journal of Farm Economics July 1929, follows.

Candidates pursuing advanced work in agricultural economics

United States	271
Germany	211
Hungary	43
Russia	29
England and Wales	13
Austria	11
Czechoslovakia	4
Canada	3
Ireland	3
Poland	3
Switzerland	2

Many Canadians are being trained in this field in the United States. In most lines of educational effort we train our own men and many for export. In this particular field it is as yet necessary to send our men elsewhere for their training.

The increasing number of graduates in agriculture entering the business field prompted your committee to solicit from this source opinions upon the need for expansion in business training. A questionnaire was addressed to over one hundred graduates now in the business field. The questions asked were three in number, namely: Do you think economics should receive more time in the allotment of studies at agricultural colleges and faculties of agriculture? Do you consider the subject should be given the standing of a major or option where this is not provided for? Do you consider the present an opportune time to make such a recommendation?

Fifty replies were received. Forty-five answered all three questions in the affirmative, an interesting variation being that five answers to the third question pointed out that ten years ago would have been a better time than the present to have expanded this work. Four replies stressed the need for greater attention to the subject but did not consider that it should be given the status of an option at the present ime. The reasons advanced included the inadvisability of students specializing in this subject at too early a stage and one suggestion was that there is no great demand for workers so trained. One reply answered all three questions in the negative, claiming that curricula are now overcrowded and that the time to specialize in this field is after graduation.

The proportion of replies to enquiries indicates that a great many of those whose opinion on this matter was solicited are interested in this problem. The remarkable unanimity of the replies is noteworthy.

Summary

The comparative popularity of specialization in this field where provision for this has been made for some years indicates that offering this opportunity is supplying what is in keen demand.

The need for strengthening the work in this line has been expressed by specialists in other fields in order to insure that graduates in agriculture who seek graduate training in agricultural economics may not be handicapped in this work by the lack of undergraduate training in this field.

There is a remarkable unanimity of opinion as to the need for strengthening the work in economics in faculties of agriculture and agrcultural colleges. Just how this may be brought about may be expected to develop some difference of opinion on account of the different organizations we now have.

Our agricultural colleges and faculties of agriculture were originally established as hybrids between demonstration farms and faculties of universities. The tendency is clearly toward making them really faculties of universities. Perhaps this historical development has led to the establishment of too many departments in some cases. If so, some consolidation may be necessary in order to provide for strengthening this work. If this is necessary, there would appear to be ample opportunity. Where this is not necessary or has already been done, it may not be difficult to provide for what is apparently considered so essential. On the other hand some organization may not require or allow a "major" or "option" in this line.

Our recommendations therefore are:

1. That in faculties committed to the major or option type of organization economics be placed upon a similar status to the options provided in other fields of study such as entomology, horticulture, agronomy, plant pathology, etc.
2. That in faculties not organized on the major or option basis, provision should allow students who so desire to secure sufficient undergraduate training in economics to insure that they will not be handicapped in graduate work on account of lack of undergraduate training in this field.
3. That the option or major provided be based on training in economics—to include marketing and farm management—but also to include such fundamentals as principles of economics, money and banking, transportation, international trade, public finance and taxation.

Perhaps the greatest difficulty in our path is the scarcity of trained men to carry on this work. This is in itself one of the greatest arguments for these recommendations. All of which is respectfully and hopefully submitted not merely to advance the claims of those most interested in this subject as a pedagogical problem—although this appears to be the important work inherited by your committee for this year—but also as a necessary step towards the enhancement of the prosperity, prestige and dignity of the industry the interests of which have brought us now together.

REPORT OF C.S.T.A. COMMITTEE ON GENERAL MEMBERSHIP

H. G. Crawford, *Chairman.*

On behalf of the C.S.T.A. Committee on General Membership, I wish to present the following report:

The committee consisted of 14 members appointed at the last annual convention and was charged with the duty of bringing the membership up to 1200.

The objective, it has already been observed by the Acting General Secretary's report, was not attained, the membership at the moment being but 1163 for all classes, some 37 short of the desired number. The 1163 total represents 1118 regular members, 6 life members and 39 student members, an increase for the year of 79.

The activities of the year were undertaken under the chaperonage of the late General Secretary. A most attractive grey covered, eight-page handbook was prepared by the General Secretary purporting to have been prepared by the committee. The booklet gave an interesting and most lucid outline of the Society, listing the officers and outlining its history, organization, financing and activities in a most interest-compelling manner, stressing finally the advantage to the society of additions to the membership and encouraging and inviting all eligible to identify themselves with the organization.

This pamphlet was sent, through the General Secretary's office, to a selected list of (1) those eligible for membership who had never joined the society, (2) students in the graduating year in our agricultural colleges and members of affiliated societies and (3) former members of the C.S.T.A. These were sent direct to the individual, accompanied by a suitable covering letter extending an invitation to join and urging the perusal of the booklet. In the letter to the former members special stress was laid upon our desire to receive from them suggestions as to how the society could be made to more completely meet their needs. Ten copies of the booklet were also sent to each group secretary for his information and possible use. After the dispatch of the letters accompanied by the booklet to the individuals being approached, a list of those being canvassed in any general region was sent to the member of the committee in that region for his guidance and reinforcement. In all 650 copies were printed of which 504 were sent direct to individuals, the rest being distributed through other channels and likely to find their way to those to whom they would make the greatest appeal.

The response from those to whom direct appeals were sent was remarkably meagre. Of the 504 approached but 30 (5½ per cent), recognized the appeal by joining. As a consequence we are forced to the conclusion that this method of approach is most ineffective and should be abandoned.

In its stead we would recommend the more painful process of a thorough analysis of the eligible personnel of agriculture in the Dominion, the definite location of each individual in a specific locality and his direct canvass by a colleague or personal friend, selected and under the direction or encouragement of a regional member of the general membership committee, clearing, of course, through a chairman located at Ottawa in contact and assisted by the General Secretary.

The effective approach to the problem of materially increasing membership requires a systematic analysis of the available material. One hundred per cent membership is, of course, beyond hope but there is little doubt but that a large increment of regular members could be added apart from the recruiting from the graduating class of the year, if a definite policy of attack were adopted by a semi-permanent committee. The semi-permanence of the committee being important in that it allows of continuity of study and canvass, avoiding the present sporadic and discontinuous system of approach.

A study of the ebb and flow of our membership is most interesting and our tentative and preliminary glance at some of the trends indicates the interest and value of keeping the closest watch upon the situation. Thus the bald statement of a net increase for the year summarizes quite a complicated situation. When the year's membership activities are studied we note that we lost 66 members in one way and another, 3 by death, 4 by formal resignation, 34 student members by graduation and 25 regular members by removal from the rolls due to default in dues. On the other hand a total of 145 new members were added to the rolls, 106 full members and 39 student members. Of the 106 full members joining, 99 joined the society for the first time and 7 rejoined, having formerly belonged to the C.S.T.A. and resigned.

Glancing rather carefully at the resignations, and those struck from the rolls due to failure to continue to pay their dues, the list in general indicates no concerted withdrawal of any natural grouping, such as by schools, graduation year, years of joining the society, agricultural or other interest. By graduating schools the list is distributed as follows: Toronto 10, McGill 3, Montreal 3, British Columbia 2, Laval 2, Manitoba 1, Alberta 1, London 1, Vermont 1 and Louvain 1. In the distribution by professional interests we find, missionaries, teachers and foresters 1 each, editors 2, professors 2, county agricultural agents 3, farmers 4, and of those with commercial affiliations 4, with two or three others in doubt. Broadly, most of these arise from change of work or center of interest and cannot be attributed to a particular dissatisfaction with the society or its work. The loss can almost be looked upon as a normal one and to be expected from year to year in a society as large as ours.

Our rather prompt dropping of members in arrears may, here and there, result in losing an absent-minded member, but in general does not seem to be affecting any significant number and the prompt cutting out of dead wood keeps the membership tree all sound timber.

Of the 145 joining the society, the 39 student members represent about 20 per cent of the total enrolment, a proportion which should be considerably increased, with a little more direct contact by an official of the society. Of the 106 joining as full members during the year we find 15 colleges and universities represented. These are distributed by schools numerically as follows: Toronto 27, Saskatchewan 18, McGill 16, Alberta 8, British Columbia 8, Manitoba 7, Laval 4, Montreal 3, Pennsylvania State 2, and the Universities of Liverpool, Glasgow, Wales, Oregon State, Rutgers and Sorbonne 1 each. We thus seem to be tapping the available material over a very wide front.

It might naturally be expected that with the passage of time and the canvass of the older graduates our membership would be increasingly drawn from the more recently graduating classes. This is conspicuously true only of the graduating class of the year. The class of 1929 supplied 40 of the 99 members joining for the first time. The other 59 came from 18 different graduating years and extending back to 1892, the precise distribution being: 1929, 40; 1928, 9; 1927, 6; 1925, 4; 1924, 4; 1923, 7; 1922, 5; 1921, 2; 1920, 4; 1919, 2; 1918, 2; 1917, 2; 1916, 2; 1915, 3; 1914, 1; 1912, 1; 1907, 1; 1906, 1; 1892, 1. This is to us a most interesting and hopeful circumstance, which coupled with the tendency shown later for men to rejoin the society gives promise of the possibility of enrolling eventually an unusually large proportion of those eligible in the organization.

It was our intention to make an analysis of the membership of the society and the eligibles in the Dominion, to determine the proportion of those eligible for membership already in the society and prepare the groundwork for further canvass along professional interest lines. This work, however, has not proceeded far enough to be of value though far enough to indicate that it is well worth doing.

In connection with this matter and following the study of the resignations for the year, some attention was given to the resignations from the society during the last ten years. This was quite illuminating and shows that in building up our 1118 regular members at present in the society 341 others have joined and definitely resigned, 117 joined, resigned and joined again and 27 joined, resigned, joined again and resigned, making a total of final resignations, by one avenue or another, of 368. The most interesting point is the uncertainty in the minds of a large body of men which would make possible 144 resignations which were followed by rejoining even though 27 men dropped out again later. The withdrawals have been particularly heavy among the charter members, 235 of them having resigned at one time or another and 158 of the original 417 not now belonging to the society.

The resignations from a study of their distribution in time seem not to be correlated with any outstanding events in the society's activities. The two most striking years being 1924-1925 with 83 and 1927-1928 with 82; 1926-27 came next with 66, the next preceeding being 1922-1923 with 56. The high years are not controlled by the resignations from any particular years of joining, the loss in 1924-1925 being dominated by the loss of charter members, and that 1927-1928 being controlled by losses among those joining in 1925. The reduction in the annual dues seems to have had no influence upon the resignations nor would we say from the incomplete analysis to date had the place of meeting of the convention any definite influence one way or another.

The tendency to rejoin is interesting. One hundred and twenty four rejoinings took place during the history of the society, this tendency being most noticeable among the charter members among whom were 83 rejoinings. The trend has continued from year to year throughout the life of the society, though 1925-1926 was the banner year in this respect with 36 men joining in this calendar year.

The whole analysis, sketchy as it has been, is most promising from the point of view of the continued increment of membership. The absolute rate of resignations is decreasing very markedly, the tendency among those who have dropped out to rejoin is shown to be surprisingly strong and the reservoir of eligibles is still very large. To these latter it becomes easier yearly to demonstrate the value and worthwhileness of the society, the increasing prestige of which alone will make an appeal. If a systematic, regular canvass by individuals can be maintained there is not a shadow of doubt but that the membership can be materially increased and a portion of the eligible personnel of agriculture in the Dominion included in our membership in excess of any society of its size on the continent.

LE PROBLEME DE L'EAU DANS LE SUD DE LA SASKATCHEWAN

F. G. Corminboeuf
Professeur au Collège de Gravelbourg

(continuation du numéro de juillet, 1930)

Pour atteindre les résultats espérés nous avons élaboré le programme ci-dessous suivant lequel les investigations seront désormais poursuivies.

Programme General des Recherches

1 ère Partie

(A) Relation entre la profondeur, la quantité et la nature des impuretés de l'eau.

(1) Analyse chimique d'échantillons d'eau prélevés à différentes profondeurs.

(2) Examen des échantillons au point de vue biologique.

(B) Relation entre la nature des impuretés minérales et les constituents solubles du sol.

(1) Analyse chimique d'échantillons de sol prélevés à différentes profondeurs.

(2) Examen des échantillons au point de vue biologique.

(C) Conclusions mineures:

(1) Etablissement de la corrélation existant entre A et B par comparaison des résultats obtenus.

(2) Illustration de cette corrélation au moyen de diagrammes.

2 ième Partie

(A) Essais d'amélioration de l'eau.

(1) Méthode mécanique (recherche du meilleur système utilisable, dans le but de prévenir les infiltrations d'eau alcaline).

(2) Méthode chimique (essai de diverses substances destinées à précipiter les sels solubles).

(B) Conclusions générales:

(si les conclusions mineures sont telles que présumées, les méthodes mécaniques interviendront en premier lieu).

Plan D'Investigation

1ère Partie

Travail extérieur.

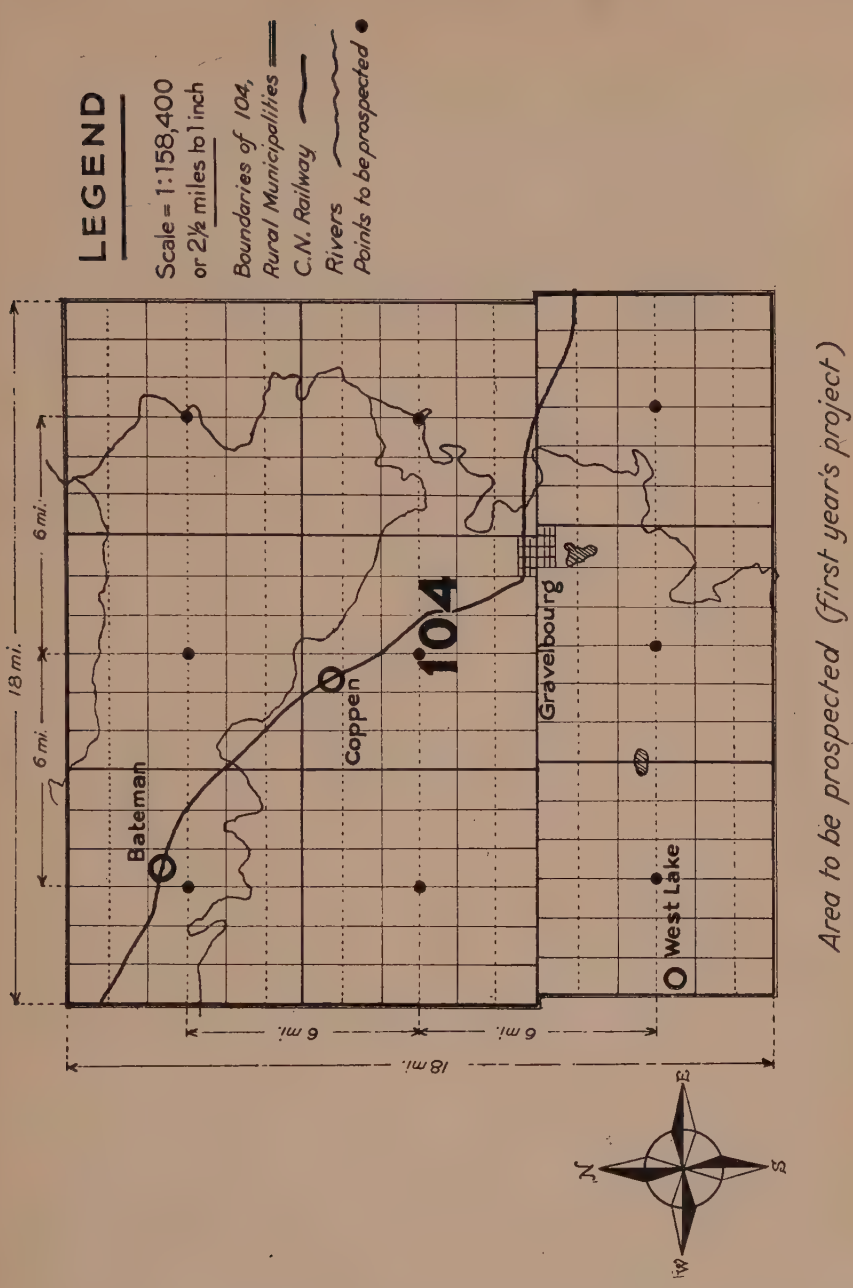
(a) Forage (projet de première année, voir la carte ci-dessous).

(1) 9 trous de sondage à 6 milles de distance dans deux directions et couvrant une superficie de 324 milles carrés.

(b) Echantillonnage.

(1) Un échantillon de sol prélevé en duplicata à chaque stratum pour l'identification minéralogique.

(2) Un échantillon de sol prélevé en duplicata dans la nappe aquifère pour l'identification minéralogique et l'analyse chimique quantitative.



(3) Deux échantillons d'eau, prélevés en duplicata dans la nappe aquifère au niveau de chaque stratum différent; l'un pour l'analyse chimique quantitative, l'autre pour l'examen biologique.

(c) Etiquetage.

(a) Les échantillons seront libellés:
Ml^{n} et ml^{n}, Cl^{n} et cl^{n}, Bl^{n} et bl^{n}.

M et m représentent les échantillons dupl. pour l'examen minéralogique.

C et c représentent les échantillons dupl. pour l'examen biologique. n, représente la profondeur en pieds du prélèvement de l'échantillon; l, représente le lieu de provenance.

Travail de laboratoire. *2ième Partie*

(a) Travail préliminaire:

(1) Examen de la structure et de la texture des échantillons de sol.

(2) Pulvérisation des échantillons de sol pour l'uniformité.

(3) Essais physiques de l'eau (goût, transparence, point d'ébullition, etc.).

(b) Analyses chimiques quantitaitves.

(1) Sol: les constituents solubles seront extraits par l'eau sous la pression existant dans le sol à l'endroit du prélèvement des échantillons. L'analyse sera pratiquée sur la matière sèche obtenue par l'évaporation et la dessication jusqu'à poids constant d'un volume déterminé de la solution.

(2) Eau: analysée de la même manière et en plus, détermination des degrés hydrométriques.

(c) Examen biologique:

(1) Sol: Nombre et types spécifiques de Bactéries déterminés par les méthodes de dilution et de culture. Examen au microscope.

(2) Eau: (mêmes méthodes).

Travail de bureau: *3 ième Partie*

(1) Classement des résultats pour mettre en évidence leur signification.

(2) Etablissement de profils de sol suivant les directions Nord-Sud et Est-Ouest dans le but de montrer la superposition des stratas, la position et la profondeur de la nappe aquifère.

(3) Notation de tous les détails pouvant intéresser l'Agriculture, la Géologie et les Mines.

But scientifique.

Notre projet ainsi qu'exposé précédemment, nous permettra d'aboutir à la connaissance chimique:

(1) de la nappe aquifère souterraine à diverses profondeurs.

(2) de la zone de terre baignée et de celle avoisinant la nappe aquifère.

Cette connaissance nous sera révélée par l'analyse quantitative d'un grand nombre d'échantillons d'eau et de sol prélevés systématiquement à des profondeurs variable sur un territoire assez vaste. Les chiffre d'analyses exprimant en grains par gallon la quantité des solides totaux seront mis en tableau et classés dans l'ordre des profondeurs croissantes des échantillons analysés. Sur la même table, et classés dans le même ordre, apparaîtront les chiffres relatifs aux analyses de sol et exprimant en grains la quantité des solides susceptibles d'être solubilisés par gallon d'eau distillée agissant sous des pressions artificielles variables. (Epreuve expérimentale).

Sur une deuxième table apparaitront les formules représentant la nature des impuretés chimiques de l'eau en regard du stratum identifié et localisé à la prise de l'échantillon. Ainsi, il sera facile de construire, à l'aide de ces deux tables, des diagrammes capables de nous renseigner rapidement et exactement sur la valeur des relations A et B, mentionnées au programme. A cet effet, il suffira d'établir, à l'aide de la première table, un graphique comportant deux variables: la profondeur en pieds suivant la ligne des ordonnées, et la quantité des solides totaux, en grains par gallon, suivant la ligne des abcisses. Les points de la courbe seront obtenus par interpolation. Au moyen de la première table encore, et avec les deux autres variables, il sera possible d'obtenir de la même manière la courbe de la deuxième relation.

Le rapprochement calculé de ces deux courbes nous permettra d'établir, en troisième lieu, le graphique corrélatif des relations figurées de A et B.

LE NOUVEAU SECRETAIRE GENERAL DE LA C. S. T. A.

Au cours du dixième Congrès annuel de la C. S. T. A. qui s'est tenu à Wolfville, Nouvelle Ecosse, du 23 au 26 juin dernier, le conseil de direction à l'unanimité a nommé M. Howard L. Trueman Secrétaire Général de l'Association en remplacement du regretté Fred H. Grindley. M. Trueman est le fils de M. John M. Trueman, Principal du Collège d'Agriculture de Truro, Nouvelle Ecosse. Il est né en 1897 à Brookings, Dakota du Sud, et a fait ses études au Collège d'Agriculture de Guelph, Ontario. Depuis 1924 il était agronome du Comté de Grenville dans l'Ontario.

Le Congrès de Wolfville s'est montré un plein succès. Les différentes sections des Provinces Maritimes qui se sont occupées, soit de l'organisation du Congrès à Wolfville même, soit des voyages à travers le Nouveau Brunswick, la Nouvelle Ecosse et l'Ile du Prince Edouard, ont certes droit aux remerciements et aux chaleureuses félicitations de toutes les autres sections pour la belle réception qu'elles leur avaient organisée. La seule tache à l'éclat du Congrès fut l'absence de Fred Grindley auquel un bel homage fut rendu au début du Congrès par M. Barton, Doyen du Collège McDonald. Le succès du Congrès fut en lui-même un bel hommage posthume à l'oeuvre de Fred Grindley. Celui-ci bâtit la C. S. T. A. et la bâtit si bien que même sa mort n'empêchera plus l'Association de prospérer.

M. Trueman prendra possession de son nouveau poste vers le 1er août. Il a l'intention de visiter les différentes sections aussitôt qu'il le pourra après s'être mis au courant de la routine du travail à Ottawa. Nous sommes certains qu'il saura comme son prédécesseur gagner l'estime, la confiance, et s'assurer la coopération entière, de tous les membres de langue française de la C. S. T. A.

H. E. L.

CONCERNING THE C.S.T.A.

General Secretary Takes Office

On taking up the duties of General Secretary of the C.S.T.A. and Managing Editor of *Scientific Agriculture*, I would have hesitated in so suddenly widening my working horizon from the borders of a rather small county to the far shores of this Dominion of Canada, had it not been for the many warm messages of confidence that came both before and after my appointment at the recent annual convention. Many helpful suggestions came with these messages and more would be welcomed especially from those members with whom I am not yet acquainted. Any ideas C.S.T.A. members may have regarding the activities of the Society will be gladly received as an expression of their own concern for our mutual welfare. Dr. Macoun and I expect to visit all the locals during the next few months and hope to become acquainted with many of the members.

The Maritime Convention was splendid. Watching the growing strength of the organization there came to mind a phrase from Dr. Durant's *Story of Philosophy*. He speaks of "the periodicals in which current science hides itself for a decade of probation." Surely we of the C.S.T.A. are emerging from a "decade of probation." Only Fred Grindley and those who travelled the road with him know how hard that probation was. If we come to our full measure of service during the next decade, it will be because they did their work faithfully and well.

Howard L. Trueman.

Le Secretaire General Entre en Fonctions

Lors de mon entrée en fonctions comme Secrétaire Général de la C.S.T.A. et Rédacteur en Chef de "La Revue Agronomique Canadienne", j'aurais hesité à élargir si soudainement ma zone d'activité des limites assez restreintes d'un comté jusqu'aux lointains rivages du Canada, n'eût été les nombreux messages de confiance qui me sont parvenus, après comme avant ma nomination, lors du récent Congrès annuel. Maintes suggestions utiles m'ont été faites au cours de ces messages; d'autres suggestions, particulièrement de la part des membres avec lesquels je n'ai pas encore lié connaissance, seraient les bienvenues. Toutes les idées que peuvent avoir les membres de la C.S.T.A. au sujet des activités de la Société seront reçues avec plaisir, car ces communications montrent que les membres prennent à coeur le développement de nos intérêts communs. Le Dr. Macoun et moi-même pensons visiter toutes les sections au cours des quelques mois qui vont suivre; j'espère ainsi faire la connaissance de la plupart des membres.

Le Congrès dans les Provinces Maritimes fut splendide. A regarder la force croissante de notre organisation, il venait à l'esprit une phrase du Dr. Durant dans son "Histoire de la Philosophie". Il parle des "périodiques dans lesquels pour une décade d'essai se cache la science du moment." Certainement nous de la C.S.T.A. sommes sortis de cette "décade d'essai".

Seuls, Fred Grindley et ceux qui one fait le chemin avec lui savent combien dur a été l'essai. Si nous pouvons rendre notre pleine mesure de services au cours de la prochaine décade, c'est parce qu'ils ont travaillé avec foi, et bien.

Je suis particulièrement heureux de la confiance qu'ont placée en moi les membres de langue française de la Société. C'est mon désir sincère d'être dans l'heureuse position de beaucoup d'entre eux, qui sont capables de parler les deux langues. Je saisirai avec reconnaissance cette occasion offerte par ma nouvelle position de me familiariser avec le français. Tandis que je prévois maintes heures laborieuses passées en compagnie du dictionnaire et de la grammaire c'est un travail que depuis quelque temps j'envisageais d'entreprendre et auquel, libéré maintenant des détails qui prennent le temps d'un agronome de comté, je vais enfin pouvoir me consacrer. Ce sera un plaisir pour le Dr. Macoun et moi-même de visiter d'ici à peu de temps les diverses sections de la Province de Québec.

Howard L. Trueman.

Notes and News

J. K. King (McGill '13), who has been with the Canadian Co-operative Live Stock Producers in Toronto for the past year has been trasferred to the Province of Quebec with headquarters in Montreal. His mailing address is, c/o Canadian Co-operative Live Stock Producers, Ltd., 327 Bridge Street, Montreal, P.Q.

J. N. Bird (Toronto '23) has been appointed Lecturer in Agronomy at Macdonald College, P.Q.

J. A. Martin (Montreal '28), who has been taking graduate work at Cornell University in farm management is now with the Department of Agriculture, Quebec, P.Q.

James Murray (Toronto '02), District Agriculturist under the Alberta Department of Agriculture for the past eight years, has received the appointment of Principal of the School of Agriculture, Olds, Alta.

J. H. Tremblay (Laval '17) has been appointed District Agriculturist under the Alberta Department of Agriculture with headquarters at Edmonton, Alta.

W. E. Ashton (McGill '20) has resigned his position as Field Representative with the Canadian Jersey Cattle Club and has joined the staff of Messrs. B. H. Bull & Sons, Brampton, Ont.

K. C. Thorneloe (British Columbia '28) has been appointed Lecturer in Dairy Husbandry at the Manitoba Agricultural College, Winnipeg, Man.

W. H. Wright (Toronto '12) has received the degree of M.S. from the University of Toronto.

Albert Gosselin (Laval '15), who for the past seven years has been Field Husbandman at the Central Experimental Farm, Ottawa, has been appointed Agricultural Economist with the Agricultural Economics Branch of the Dominion Department of Agriculture at Ottawa, Ont.

W. S. Chepil (Saskatchewan '30) has been appointed Superintendent of the Weed Experimental Station at Drinkwater, Sask.

Ellis McMillan (Saskatchewan '27) has received the degree of M.Sc. from the University of Saskatchewan.

Appplications for Membership

The following applications for regular membership have been received since July 1st, 1930:

Letourneau, L. (Montreal, 1929, L.S.D.) Amos, P.Q.
Logan, V. S. (McGill, 1930, B.S.A.) Amherst, N.S.
Preston, S. G. (B. C. 1930, B.S.A.) University of Alberta, Edmonton.
Webster, C. A. (Toronto, 1913, B.S.A.) Dept. of Agriculture, Toronto.

BOOK REVIEW

Bacteriology. By Stanley Thomas, Professor of Bacteriology, Lehigh University. McGraw-Hill Book Company, Inc., New York. Second edition, 1930. Price $3.00.

The past decade has seen the appearance of a relatively large number of books on bacteriology and microbiology in which attempts have been made to give just emphasis to the various sides of the subject in contrast to the earlier works which treated of bacteriology almost wholly from the medical angle.

The present work is the second edition of a short text-book designed primarily for elementary students and written with the object of presenting the fundamentals of the subject which may serve as a basis for later specialized work. The book is planned in the conventional manner, in which earlier chapters on history, classification, morphology, physiology and cultivation of bacteria are followed by short chapters treating of bacteria in soil, water, air and foods, with three chapters dealing with pathology, immunity and hygiene. A chapter on bacteria in industry completes the volume.

In a work of less than 300 pages, attempting to cover the whole field, it is obvious that anything like an adequate discussion of any of the phases of microbiology is impossible, and consequently only comparatively brief outlines of the subjects suggested by the chapter heads can be expected. Thus soil microbiology is described in 17 pages, while dairy bacteriology receives the briefest mention in the chapter on foods. Even in a text-book designed to cover fundamentals one might have wished for a fuller discussion of related microörganisms than possible in the single chapter alloted. The reviewer found the chapter on the history of bacteriology the most interesting and original.

At present the elementary student appears to be fairly well provided with a choice of text-books, and although the present work may be studied with profit yet it does not appear to present much which is not already adequately covered in similar works. A useful feature is seen in the fairly numerous footnote references, even though in the case of the German references rather frequent typographical errors are apparent.

A.G.L.

SUBJECT INDEX TO VOLUME X

English Articles

Articles français

AUTHOR INDEX